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ABSTRACT

This document presents four studies on the educational systems of the Federal Republic of Germany, France, Italy, and the United Kingdom, focusing on the teaching of technology in the lower secondary schools. Educational trends and brief summaries of education in other European countries are also outlined by the editor. Common trends indicated are: (1) raising of the school-leaving age to 14, 16, or even 18, (2) the appearance of a middle school, through which the majority of enrolled pupils of 12 to 15 or 16 years of age pass, and (3) introduction of experimental use of a new subject or a new method of teaching known as "technology." The editor's concluding remarks state: "An educational system which will not accept technology is an educational system which turns out cultural cripples....The training of teachers must be enlarged and space and equipment must be provided to include technology as a coherent element of an educational system." The Council of Europe's research over the past 10 years brought on awareness of the need to integrate technical training with general education. Although the terms "technology" and "technical education" are used in the document, its contents indicate that the innovation referred to represents the concept of career education. (MF)

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THE TEACHING OF TECHNOLOGY

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Strasbourg, 8 May 1972

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COMMITTEE FOR GENERAL AND TECHNICAL EDUCATION

THE TEACHING OF TECHNOLOGY

A symposium under the
editorship of

Y. DEFORGE

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INTRODUCTION

I. GENERAL CONSIDERATIONS

The first impression which emerges from reading the following studies or from considering the educational systems of other European countries not represented in this Symposium of articles is that of a common trend as regards three points:

(1) Raising of the school-leaving age to 14, 16 and indeed even 18.

(2) The appearance, in all systems, of a middle school, through which the majority of enrolled pupils of 12 to 15 or 16 pass. This "observation and guidance period" corresponds generally to the first four years of secondary education (sixth to ninth grade in European terminology).

(3) Introduction of experimental use of a new subject or a new method of teaching at this level known as "technology" or better as "technical education".

The underlying reasons for thus introducing technical education may be of some interest.

We shall not dwell on the origins of the term and the concept (1). We would briefly point out, that since the dawn of industrial mechanisation in Europe, there has always been a more or less perennial current of thought in universities concerned with the consequences of technology, and which appears to have originated with a German, J. BECKMANN, a doctor of fiscal sciences at Goettingen University. It seems to contrast clearly with the practical technology which the technician experiences (2) and apart from this undercurrent in universities, there was nothing to enable young people to understand technology as such, except for practical work.

Why should things be any different today? First and foremost compulsory schooling and the middle school bring together, within a single system, a more varied and less motivated school population than in the past. A more democratic educational system will not be successful if changes in structure are not accompanied by revised curricula and new teaching methods to provide positive guidance to all pupils in middle schools.

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(1) Cf. Y. DEFORGE, Aperçu historique sur les origines de la technologie in "Apprendre à apprendre" Encyclopédie du CEPL, Paris 1971.

(2) BECKMANN (J.), Anleitung zur Technologie, Goettingen, 1780.

In this context technical education is seen everywhere as having to fulfil three purposes:

(1) To facilitate observation of students, either individually or in teams, faced with a specific problem requiring them to dismantle, reassemble and to create objects of their own design;

(2) To promote guidance, particularly towards technical and scientific education, by arousing positive motivation;

(3) To give both boys and girls the tools to understand the environment in which they live; an introduction to technology, interpreting diagrams, methodology, and the organisation and sociology of work (1).

This latter point alone is sufficient justification for technical education. The natural environment of children living in our industrially developed countries is increasingly technical. The child is in constant contact with technical objects: household electrical appliances, motor cars, various machines, etc. Quite independently of any new educational idea, it makes sense that technical objects can be studied by the same methods and within the framework of traditional disciplines such as the physical sciences, the natural sciences or history. This tendency to merge the subject with others, justified though it may be, leads to a certain amount of confusion since technology as an entity thereby disappears, even if the name is still used.

Lastly the trend towards the standardisation of European educational systems and of curricula can be explained by international conferences (SEVRES seminars, Council of Europe symposia) or by cultural exchanges which lead to the rapid circulation of ideas in Europe and beyond. Deliberate imitation also plays a part in certain choices.

However, since technical education is outside the framework of traditional formal subjects and is still flexible, it leaves teachers an appreciable margin of freedom. This rather blurred aspect is both its strength and its weakness and therefore, on the European scale, there is no single form of technical education but several different forms. This emerges particularly clearly from the German Federal Republic's report.

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(1) Council of Europe report on the Symposium on upper secondary technical education. CCC/EGT (69).

It is therefore interesting to become acquainted with each system from a general outline of their special features.

II. MAIN TRENDS

To show the main trends we must have recourse to excessive simplification. The reality is rather more complex, as will be seen from the reports which follow.

We shall distinguish four main purposes and four different forms of teaching.

1. The four purposes

These colour technical education. The first two are inspired by social and human, the other two by psychological and educational considerations.

A. Technology and social education: the polytechnic approach

The guiding principle is that the school should not be cut off from the outside world and particularly not from the world of work. Polytechnical education tends to give the child a place in a particular social system by ensuring for him very real contacts with workers of all kinds.

B. Technology and people: group work

By contrast with polytechnical education the purpose of group work is to include the pupil in a group of people rather than in a particular society. This involves motivating the group, first through designing and then through manual work. Each child must find his proper place according to his ability, his ambitions and his knowledge.

C. Technology and interdisciplinarity: the project method

The project method stems from psychological and educational considerations. It makes the study of a technical problem a centre of interest to which the other subjects contribute both practical skills and information. The general direction is towards synthesis and practicality.

D. Technology and disciplinarity: the analytical method

Technology is used as the basis for the study of one or more basic subjects which retain their traditional independence. Abstract physical concepts such as force, torque or the motions of translation and rotation, or mathematical concepts such as network applications, become clear from the analysis of real phenomena.

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2. The four forms of teaching

As the Federal German report stresses, the pedagogics of technical education introduces a variable which, although not entirely unrelated to the above-mentioned purposes, makes it possible to distinguish between four major forms of technical teaching which we give here in order of decreasing interdisciplinarity.

A. Technology as a guiding theme

To be successful, teaching by themes presupposes a single teacher who, starting from a technological theme, develops a whole spectrum of knowledge in keeping with circumstances and requirements. In its extreme form there is no longer any timetabling of separate subjects.

B. Technology as an end in itself

Where this approach is used, technical education stands above a group of subjects taught by different teachers working as a team. The pupils use technology to apply their previously acquired knowledge.

C. Technology as a subject in its own right

Here, technology is timetabled separately and is developed without any formal links with other subjects. This presupposes a proper definition of what is understood by technical education (as distinct from manual work) and the provision of properly equipped classrooms and specialised teachers.

D. Technology as a form of motivation

Here each subject teacher is asked to use technology to illustrate or form the basis of his teaching. Interdisciplinarity is more or less non-existent.

3. Approximate situation of technology in France

The table below groups the purposes and forms of technical education, but in real life, of course, such education in no case fits precisely into the squares of a diagram.

For instance, technical education in France as defined by the "Instructions Officielles", is not geared to social education at all, only slightly towards human training, more towards synthesis and very much towards analysis. It is both a subject in its own right and a supporting subject. By and large, its general aspect is therefore as shown by the shaded area.

The different types of technical education which we shall come across could also be approximately situated on the diagram. This would show that they are a long way from overlapping.

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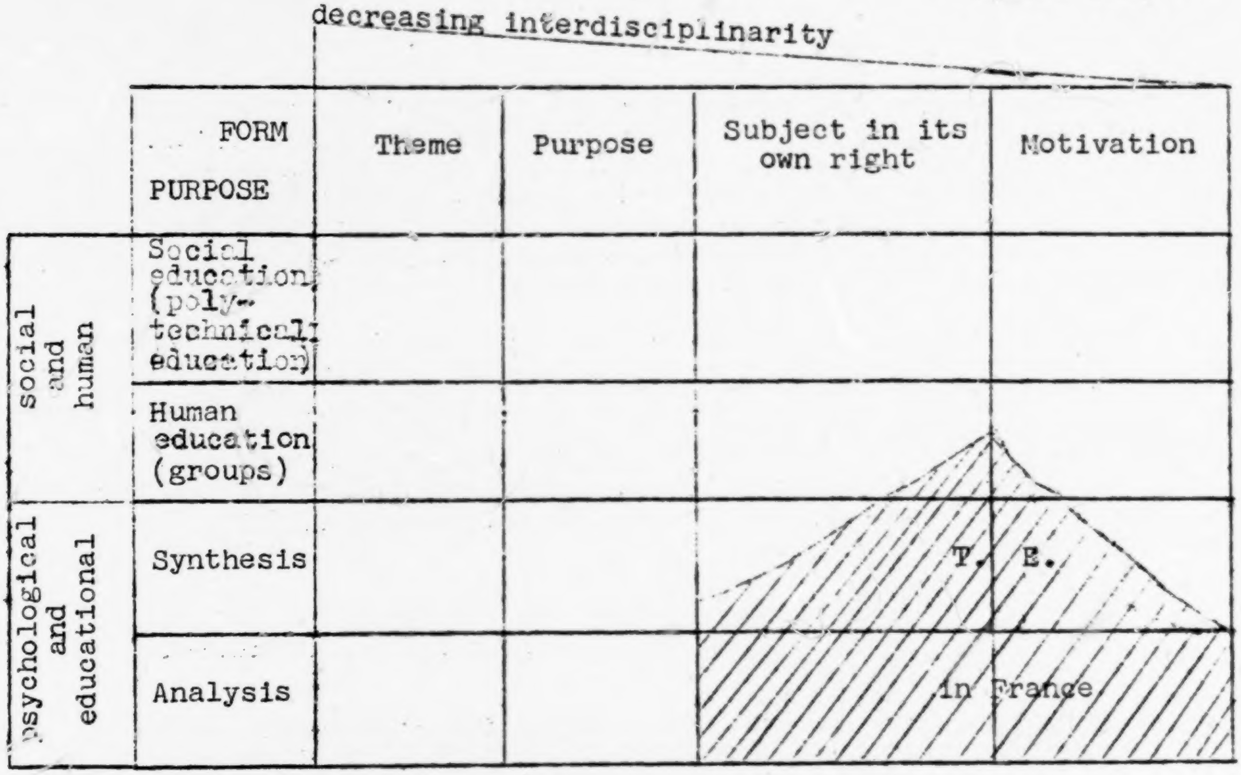

	FORM / PURPOSE	Theme	Purpose	Subject in its own right	Motivation
social and human	Social education (poly-technical education)				
	Human education (groups)				
psychological and educational	Synthesis			T.	E.
	Analysis			in	France

III. BRIEF SURVEY OF TECHNICAL EDUCATION IN DIFFERENT COUNTRIES

We give below a few short monographs relating to various European countries with a view to stressing the characteristic features of their technical education (form, purpose, compulsory or optional nature, etc.). Included are the four countries on which the reports which follow give further information.

It will perhaps be surprising to find here a short survey of technical education in the USSR and in East European countries which are only marginally European, and yet it seemed of interest to point out that the conclusions of the third seminar on polytechnic education in schools (Sofia, 1965) are precisely the same as those of the Council of Europe Seminar at Sèvres in 1968!

TECHNICAL EDUCATION IN THE USSR (1)

Technical education in the Soviet Union and in East European countries is very much influenced by the idea of polytechnic education. Lenin, (in "polytechnic education", 1920), gives a detailed plan of polytechnical studies for all pupils of 12 to 17 including practical work, visits and training courses in factories, the setting-up of small museums (we would call these collections of technical objects) and the construction of small appliances or mechanisms under the guidance of specialists.

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(1) ANWEILER (O.), Polytechnische Bildung und technische Elementarerziehung - Bad Heilbrunn, J. Klinkhardt, 1969.

To Lenin, polytechnic education was of prime importance for industrial development and increased productivity in factories. In the Soviet Union, from the outset, there was concern with creating a new drive towards technology. This objective may seem pragmatic but it should not be forgotten that at that time Russia was a poor country and its economy urgently required skilled workers and economically viable factories.

Since its beginnings, polytechnic education in the USSR has evolved from vocational training to preparation for social life and the third international Seminar on polytechnic education in schools (Sofia, 1965) was therefore able to define the relevant aims in these terms: to establish a closer relationship between school and life outside; to motivate pupils and guide them towards full technical education, and to promote technological and scientific modes of thought.

Polytechnic education existing in the Soviet Union and in nearly all East European countries is compulsory and generalised. Its development is as follows:

In primary school classes this mainly involves manual work with the construction of utilitarian objects and, if there is a school garden, the cultivation of vegetables and flowers. It should be noted that the product of the pupils' work is frequently put up for commercial sale. The pupils also have to visit factories, meet workers with advanced training and discuss production techniques.

In middle schools (fifth to eighth years) polytechnic education is increased and diversified thanks to workshops (wood, iron and other materials, electricity, internal combustion engines, etc.). All the teaching methods are linked to these activities according to the slogan "learn as you work, work as you learn" (perhaps reminiscent of Dewey). They are supplemented by club activities.

In the ninth and tenth years of study, the pupil must develop a deeper knowledge and greater ability in a specific field of activity. Practical training courses are provided, which broaden the pupil's horizon in the polytechnic field, promote interest in theoretical instruction and lay the way open for guidance.

TECHNICAL EDUCATION IN THE UNITED KINGDOM (1)

Education in the United Kingdom is characterised by what could be called "free enterprise". The organisation and curriculum vary from one county to another, and variations can even occur between neighbouring schools. Since any action taken at the top, through national curricula or official instructions, is ruled out, innovations come from the bottom and through joint effort.

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(1) UNESCO information for young people Nos. 578-579, July 1970.

It could be said that there is a general trend towards setting up a middle school (11 to 16) in which technical education can be provided in a form which reconciles what we have called the "project method" with group work.

"Project technology" which was begun in 1960 by the Schools Council is experimental until 1972 and affects only a limited number of educational establishments. This project is designed to channel into the classroom the inventive spirit and initiative which young people show in so many extra-curricula activities.

Technical education is not compulsory, and teachers and pupils choose a study theme or "pilot project" very freely and when desired this is undertaken in small groups. Young people work on their own for several weeks or even a whole term according to their particular abilities; some undertake research, and others design or write a report. More often than not the project leads to the construction of an appliance or original mechanism of which several examples are provided in the report on technology in the United Kingdom.

Many publications give examples of themes or "topics" (1). The extraordinary variety of projects developed by the groups is quite dumbfounding. From the hover train to the barometer, from an anti-theft device for babies (thought up by a class of girls) to the improvement of a watercourse or Roman oil lamps, the common denominator is that the completion of these projects involves three processes which are essential to training the scientific mind: conception, construction and the application of theoretical knowledge. English teachers have summarised their concept of technology in a quip which is lacking in neither humour nor significance. "What matters is not what John does to the piece of wood, but what the piece of wood does to John". We could say that the activity is considered more important than the objective.

From the point of view of organisation, the unusual topics selected by pupils require a great deal of flexibility and perfect co-operation between teachers, since none, despite the training courses he may have attended, is able to deal single-handed with all the problems raised by the groups. Co-ordination between subjects necessarily occurs even though it may not be formally required. And it is not unusual to see the group call in specialists from outside the school: parents, engineers, skilled workers or teachers from higher education.

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(1) "Learning about Space": Education Pamphlet, No. 55, 1969.

By contrast, the project method does not seem to demand particularly expensive equipment. English teachers feel that having to "make do" with limited means acts as an incentive to the pupils who must show initiative and imagination either individually or within the group. Prizes are awarded for the best work.

TECHNICAL EDUCATION IN FEDERAL GERMANY (1)

"Positive and negative experiments, discussions between teachers and sociologists, and the most diverse opinions, are reflected in the recommendations of the German Commission for Education set up in 1953 which as early as 1957 was inviting the Hauptschulen to take into account the requirements and techniques of present-day society, and to develop the child's awareness of technology and his ability to adjust. But it was only seven years later, in 1964, that the "German Commission", in the light of experiments carried out in the meantime, recommended modern work processes as a basis for teaching in the Hauptschule. Arbeitslehre (the term used for technical education) is seen as an introduction to the world of work and economic life.

The detailed syllabi for Hauptschulen issued by the Ministry of Education in the Land of North Rhine-Westphalia (1968), which seem to us to be the most significant, apply from the fifth to the ninth year of education (2). Technical education is compulsory. In other types of schools Arbeitslehre is still trying to establish itself.

As organised at present in North Rhine-Westphalia, Arbeitslehre includes several disciplines and activities:

- practical and theoretical technical work, introduction to elementary economics, home economics, study of the organisational structure of the firm, courses in firms.

As regards teaching methods, provision has been made for many approaches:

- exercises, manufacturing, solving simple and complex technical problems, surveys, projects, and even studies on models and simulated firms.

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(1) Trautmann (I.) Arbeitslehre, études et documents No. 17, 1970. Service central des statistiques et sondages, Ministère de l'Education Nationale.

(2) A complete technical education curriculum for Land Berlin can be found at the end of the German report.

The project method (or the method for acquiring knowledge through motivation) is the framework for complete pluridisciplinarity. All curricula are designed in the form of work programmes centred on major themes or major problems.

No subject of instruction is unaffected by Arbeitslehre which it is felt should no longer be confined to the "Hauptschulen" but should provide a new way of thinking and teaching in all classes.

TECHNICAL EDUCATION IN FRANCE

In France, technical education is compulsory and generalised in the first two years of the middle school. The fact that it is classified among the "basic subjects" should be stressed. France is the only European country to give technology such a marked place as a school subject, with specialised teachers, set timetables and curricula.

Technical education is based on the study of specific technical objects of which a list is provided in the curriculum although the teacher can always introduce innovations.

The teaching method used is analytical and the teacher must allow basic concepts of physics, mathematics, and chemistry to emerge from the subject studied. The latest "instructions", do not mention "technical education" but "physics and technology". The title alone is significant.

There is no very marked interdisciplinarity except in certain cases with mathematics and manual work. However, recent research seems to show that technical education is instilling in pupils a form of psychological transfer from which other subjects benefit and which are having a positive effect on guidance criteria. The French report clarifies this point.

Lastly, it should be pointed out that technical education which has been the subject of considerable revision over the last ten years, is once again being reviewed by a study group (primarily made up of physicists) and their conclusions will be known by 1973.

TECHNICAL EDUCATION IN SWEDEN (1)

When Swedish comprehensive schools were created in 1950 technology already formed part of the curricula. After an experimental period two choices have emerged. One based on the project method was aimed at students who were already attracted by theoretical studies. The other, for more practical students, included a larger share of practical work.

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(1) Technological Education in Sweden, Council of Europe, DECS/EGT (69) 82.

Since 1970, the two options have become one, provided to all middle school pupils in their seventh, eighth and ninth years.

The main characteristic of this subject, which is called "Tecnik" (for want of any other term), is team-work, as in the United Kingdom, with this difference that the subject for study, selected by the group with their teacher's approval, lasts for all three years.

During the first year of compulsory middle schooling, pupils study the general aspects of the subject; the second year is devoted to tesearch into technical activities, industrial organisation, and marketing and the third year is given over to the study of social and human aspects of productive work.

The group is independent and organises itself. It is properly documented, can visit factories, and public services and work in school workshops and laboratories. At the end of the period each team presents its findings to the whole of the class (reports, films, slides, recordings, experiments, equipment).

Teachers of the different subjects involved (science, mathematics, history, art) take part in drawing up the final report in an advisory capacity.

TECHNICAL EDUCATION IN ITALY (1)

In the Italian educational system, primary school is followed by a compulsory middle school (from 11 to 14). At this latter stage there is a subject called "technical application", compulsory in the first and second years and optional in the third year.

The "technical applications" approximate to manual work with technical drawing. This aspect of education seems to be relatively little developed. We do not know how far it is selected when it becomes optional. However, the Italian national teaching centre took the initiative of holding an important international meeting on technical education at Frascati in 1967 (2). If the concrete proposals made at this Symposium were

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(1) The teaching of technology in Italy (working document), DECS/EGT (69) 81 - Council of Europe.

(2) L'Educazione technologica, Centre Europeo dell'Educazione Palombi, Roma 1967.

not followed by very marked effects in Italy, the reason is, according to a recent report, that the new subjects (technical application and scientific observation) have not yet been the subject of appropriate action with regard to teaching methods and the further training of teachers.

TECHNICAL EDUCATION IN BELGIUM (1)

Up to the beginning of this new school year, apart from manual work, the Belgian educational system included nothing which resembled technical education. Following the Sèvres (1968) Seminar, a provisional syllabus for an "introduction to technology" was drawn up.

This was applied experimentally in the reformed lower-secondary educational system (12 to 14) as from 1 September 1970.

The very sparse curriculum covers three points:

- basic concepts: study of movements, metrology, technical drawing;
- technical studies of machinery;
- observation of students.

Although very much inspired by the French curriculum the provisional Belgian curriculum shows certain specific characteristics: greater freedom is given to teachers in the choice of subjects to be studied; greater emphasis is placed on discovering students' abilities and on observing them; there is special emphasis on the relationship with physics, as in the French curriculum, but also with mathematics.

TECHNICAL EDUCATION IN OTHER COUNTRIES

From the oral reports given by the representatives of countries taking part in the Sèvres Course (1968) on technology teaching in lower secondary education, it is useful to recall that the term "technology" is the source of some confusion. This confusion is aggravated by the comparison often made either with manual work, or with pre-vocational training.

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(1) Ministère de l'Education Nationale - Enseignement Secondaire Rénové - 1er degré - Initiation technologique - Programme provisoire 1970.

The Netherlands, Denmark, Luxembourg and Spain do not yet seem to have developed technical education for all sections of the middle school. By contrast, although German-speaking Switzerland does not use the term "introduction to technology" eighth and ninth year curricula do nevertheless include an introduction to technical drawing.

Finally, we should recall that many French-speaking Black African countries already provide technical education or intend introducing it in the near future. This also applies in North Africa, where Morocco and, in particular Tunisia, have made a remarkable effort to provide technical education in a form which answers the specific needs of these countries.

Strasbourg, 26 August 1971

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COMMITTEE FOR GENERAL AND TECHNICAL EDUCATION

THE TEACHING OF TECHNOLOGY (ARBEITSLEHRE) IN THE FEDERAL REPUBLIC OF GERMANY

by

W. VOELMY

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The teaching of technology (Arbeitslehre) in the Federal Republic of Germany

by

Dr. Willi Voelmy

1. Place in the school curriculum

Since 1969 when Bavaria was the last land to introduce nine years of compulsory full-time schooling the school system in the Federal Republic has been almost universally as follows:

Primary school:	1st - 4th classes; in the City States of Berlin, Hamburg and Bremen primary school consists of the 1st - 6th classes.
Upper primary school (Hauptschule):	5th or 7th - 9th classes; the 5th and 6th classes are generally designated "observation" or "development" classes (i.e. for transfer to schools that lead to higher education - technical high (Realschule) and grammar school (Gymnasuim) and may also be organised in technical high and grammar schools themselves. A number of Länder are experimenting on voluntary extension to a 10th class in the Hauptschule; e.g. in Berlin about 70% of pupils in main stream secondary schools opt for the 10th class. A good many Länder are planning to introduce 10 years of compulsory full-time schooling.
Technical high school:	5th or 7th - 10th classes.
Grammar school:	5th or 7th - 13th classes.

Teaching of technology (Arbeitslehre) in schools is still generally restricted to the 7th up to the 9th or 10th classes in upper level primary schools; only in North Rhine-Westphalia does it start as early as the 5th class. School interests and considerations of prestige still hamper introduction of the subject into technical high and grammar

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schools as well. It is to be hoped that curricula in the latter types of school will be increasingly modified as a result of the experiments in comprehensive schooling that have started up in almost every Land; in comprehensive schools technology is offered as a teaching subject to all pupils at secondary level I (7th - 9th classes) and the intention is to work out a similar course for secondary level II (10th - 13th classes).

Owing to the present general uncertainty in discussing the teaching of the new subject and its curriculum, it takes four different forms in teaching practice, which are recommended and tried out either separately or in combination:

(a) as a teaching principle:

Every teaching subject (except for foreign languages, physical education and, generally, musical subjects) is required to bring out occupational, economic and social aspects. Reference to the world of business and industry is to be made wherever opportunities occur during regular presentation of subject matter in individual subjects (Baden-Württemberg, Bremen, Schleswig-Holstein). Only rarely is there any inter-discipline co-ordination of the topics dealt with.

(b) As a teaching subject in its own right:

A specific number of weekly periods (4 - 8) are devoted to technology on the weekly time-table. Teaching has to follow a syllabus specially designed for this subject (Berlin).

(c) As a group of subjects:

"Arbeitslehre" is a term used to cover a number of subjects which appear in the time-table either as a number of common weekly periods with separate options regarding the syllabus (Lower Saxony), or as separate sets of periods with a syllabus of their own (North Rhine-Westphalia, Rhineland-Palatinate, Bavaria).

(d) As a term to refer to inter-subject themes:

Occupational, economic and sociological themes or projects are introduced under the one-teacher system (i.e. almost every subject is taught by the same class teacher) for a limited period during the school year without any division into subjects; under the specialist teacher system technological themes are given particular emphasis within an individual subject (e.g. sociology or handwork), and at the same time corresponding subject matter is covered in other disciplines (e.g. German, arithmetic/geometry, natural sciences) (Hamburg, Hesse, Saarland).

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In North Rhine-Westphalia Arbeitslehre is introduced in the 5th class, but in most Länder it does not begin until the 7th year at school, continuing until the 9th or 10th. In a few Länder only (Bavaria, Hesse and Rhineland-Palatinate) technology is mainly taught in the 9th school year.

Up to the present time no final curricula or guidelines for technology as a teaching subject have been laid down in any Land by ministries of education and instructions have mostly been explicitly referred to as "provisional". Special committees have been set up in every Land to work out new syllabuses or to finalise or revise existing ones. The recommendations of the Conference of Ministers of Education of 3 July 1969 are universally recognised as guidelines; they embody the decision to introduce Arbeitslehre as an independent teaching subject from the 7th, up to the 9th or 10th classes in Hauptschule. (8)

2. Purposes

The underlying aims of technology teaching are outlined in the official circulars of a good many Länder; they are based on the report on upper level primary education presented by the Federal Committee in 1964 (7). Generally speaking they consist simply of a few generalisations. The goals set forth are in essence as follows:

(a) to give pupils elementary technical education, to prepare them to cope with the technical side of their environment at work and in the home;

(b) to give pupils a preliminary understanding of economic and social factors in the world of industry and work and to give them examples of the links between technical, economic, political and social elements;

(c) to instil in pupils a proper attitude to work (determination, tenacity, open-mindedness, flexibility and adaptability, etc.) so that they can meet the requirements of their profession in co-operation with others;

(d) to give pupils an opportunity for vocational guidance or to develop "vocational selection maturity" i.e. to enable them to make a sensible choice of job.

These four aspects are mentioned with varying emphasis in the directives issued by almost all the Länder on upper level primary education: e.g. in Bavaria, Bremen and Hesse special emphasis is given to the vocational aspect, in Hamburg and North Rhine-Westphalia to economic and

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technical aspects and in Baden-Württemberg to correct attitudes to work, while in the Rhineland-Palatinate the accent is chiefly on technical subjects. Apart from North Rhine-Westphalia (where "Arbeitslehre" is divided into a number of subjects with a corresponding proportional attention to the ultimate aims)and Berlin (where educational goals at every level and in every individual subject are specified from the technological, economic and social angles), the aims laid down in the syllabus are, generally speaking, scarcely looked upon by teachers as firm criteria for teaching practice. What generally happens is that the aims of technology teaching are determined by the specific interests and knowledge of the individual teacher. This situation will continue as long as syllabuses contain nothing but secondary goals and as long as those concrete, primary goals, are excluded which are alone calculated to direct the educational process through awareness of the knowledge, abilities and skills required. Although the Berlin and North Rhine-Westphalian provisional syllabuses have shown in practice that they needed revising in a number of ways, they are looked upon throughout the whole of the Federal territory as models for the practical definition of goals in this field.

3. Syllabuses

Owing to general uncertainty about the practical goals and tasks of "Arbeitslehre" the guidelines supplied by most Länder still contain no systematic division of subject-matter (e.g. Baden-Württemberg, Saarland, Schleswig-Holstein) or they contain simply a catalogue of proposals for topics and the details are left to the teacher (e.g. Schleswig-Holstein).

Where it is recommended that the teaching of technology should cover inter-disciplinary themes or be mainly related to current affairs or civics, the subjects studied represent an introduction to a variety of occupations connected with manufacturing, production and services, or to the hierarchical structure of firms, the general working atmosphere, staff welfare programmes and certain industrial and economic aspects. Where the accent is primarily on the "technical subjects" (handwork, textile work, domestic science), manual tasks and the learning of work techniques receive the main emphasis. In addition, organisation of one's personal life and domestic science are subjects of instruction for girls, together with the duties of women in the family and as citizens.

So far the most detailed syllabuses have been developed in North Rhine-Westphalia (10) and Berlin (5).

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In the North Rhine-Westphalia curriculum "Arbeitslehre/ Hinführung zur Arbeitswelt" (technology - the road to the world of work) is subdivided into three subjects - technical handwork, economics and domestic science. The subject matter of "technical handwork" covers manufacturing and processing techniques (general technology), mechanical engineering and technical engineering (building). The three categories of practical objects i.e. everyday objects (equipment, tools, toys, furniture), buildings (housing, community amenities, industrial plant, traffic facilities) and machinery (power-producing plant, machines and data-processing equipment) are integrated into the above three categories of subject matter. "Economics" is divided into what are known as "fields of orientation" - needs, types of economy; market, prices, money; business cycles; economic systems and economic management. "Domestic science" consists of principles of nutrition, home hygiene, care of members of the family at different ages, health education and principles for use of leisure. The North Rhine-Westphalia syllabuses have been criticised firstly for splitting up technological instruction into three independent, relatively unrelated technical subjects and secondly for outdated treatment of the overall economic subject matter.

In contrast, the Berlin syllabus conceives of "Arbeitslehre" with its various technological, economic and social aspects as one indivisible whole presented in the 7th to 10th classes as a single subject without any further subdivision, a wide variety of inter-subject links are to be established with other disciplines (geography, mathematics, German and natural sciences). Subject matter is covered in three stages - "production for personal needs", "production for an individual contractor" and "production for the market in general". Characteristic of the Berlin model is the endeavour to select teaching matter in such a way as to enable pupils "to see how economics and technology are conditioned by social factors, to assess them from the point of view of their own interests and to further technical, economic and political developments in the world of work and consumption so as to give every individual citizen a greater opportunity to be his own master" (5 P.3). Corresponding teaching matter in the 7th to 9th classes is derived from the following so-called specialised fields - metalwork/electro-technology, woodwork and work in artificial materials, textiles, domestic science (nutrition), household economy and private pursuits; at the present time instruction that varies according to seven different occupational fields is being considered for the 10th class - building, electro-technology, nutrition, mechanical engineering, economics and administration, social education and social work. (For examples of contents of these syllabuses, see Appendix.)

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4. Teaching methods

These generally consist of the following, either separately or in combination: courses, exercises, projects (Vorhaben and Projekte) industrial surveys and practice Courses serve to pass on information to pupils, mainly by deductive means, on technology, economics, sociology and occupations. Exercises develop in the pupils skills in handling materials and tools or in collecting, ordering and evaluating information. The terms Vorhaben and Projekt have a great many meanings in German education; but the definition set forth in the Berlin model, which owes much to Wolfgang Klafki, is gaining ground in other Länder as applied to "Arbeitslehre". According to that definition Vorhaben means a piece of educational work planned and executed by the pupils with the help of the teacher, but to a large extent independently, leading to a pre-defined practical result, e.g. a manufactured article, a plan or action, or an analysis (e.g. of the organisational structure of a firm). A Vorhaben always has the aim of illustrating and bringing out the relationships to be found in the world of business and industry by means of practical work by the pupils, supported by interpretation and reflection. A Vorhaben includes, besides its main substance, i.e. the actual project itself, the necessary courses and exercises required for its execution. On the other hand, the word Projekt refers to the actual realisation of the end-product of the Vorhaben, i.e. the making of the article or the execution of the plan, action or analysis.

Thus industrial surveys and practice are to be taken as "Vorhaben", for both aim at analysing actual factors in the world of business and industry on the basis of specific examples (e.g. production firms or service firms, hospitals, nursery schools, administrative offices, etc.).

Industrial surveys consist of visits lasting two or three hours to selected departments or places of work in a firm; by whole classes or groups of pupils with tasks, including questionnaires, previously decided on in class; observations are made and staff, managers, works committee are interviewed, etc. The information thus obtained is then assessed in class and leads to general views of relations in the world of business and industry. Industrial surveys generally take in some functional (technological), social, economic or occupational aspect and so in North Rhine-Westphalia they are also designated "Aspekterkundungen" (aspect surveys). A complete series of models for surveys of this kind, notable for their inter-regional validity, wide utility and adaptability to very diverse local situations, are being developed by representatives of industry (training

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managers) and experienced teachers from all the Länder at the Technical Training College for Teachers in Bad Harzburg; and are being published (19). As yet no scientific research has been done on the possibilities and limitations of industrial surveys as part of technology teaching.

Practice (industrial or social practice) is done mainly in two ways, either as "block practice" (pupils work for 3 weeks without a break in a firm; e.g. in Hamburg and Berlin) or as "day practice" (pupils work in a firm for a number of months for one day per week; e.g. in South Baden and Upper Franconia). Both types vary from place to place. Most Ministries of Education have issued official decrees concerning arrangements for periods of practice in firms, which deal primarily with organisational and legal questions (e.g. 23, Book 5, p. 59 et seq.) but to some extent also contain educational and methodological guidance (e.g. 23, Book 4, p. 87 et seq.). On no account is it the aim to steer pupils into an occupation, or give them "trial apprenticeship" or influence them in their individual choice of occupation. The object is, above all, to provide general training. To elucidate the point we may quote the Berlin Rules which are typical of all such arrangements:

> "Practice in firms should provide an opportunity for close observation of reality, and thus personal experience should assist application and extension of the information obtained in the classroom;
>
> It should help the pupil to realise that work which adapts to changing situations requires reflection and the taking of decisions;
>
> It should give pupils insight into the social structures of the world of work;
>
> It is of general instructional and educational value and provides an introduction to industrial and professional world;
>
> It is not to serve as a means of discovering inclinations for particular occupations or as a means of providing jobs."
>
> (23, Book 4, p. 87)

The total number of classes taking part in such practice (in special schools and in technical high schools as well) has been constantly on the increase in all the Länder in recent years, and we are already hearing of proposals to make such practice compulsory (e.g. in Hamburg and Berlin).

But in practice none of the teaching methods mentioned above is alone sufficient. Thus in the most recent attempts to develop a complete and comprehensive "Arbeitslehre" methodology we find all the various methods fused into one: projects (consisting of courses, exercises and the finished article) give the pupil, through trial and error, simple initial basic experience and conceptions of the technical, economic, social and professional factors affecting any production or service procedure, while still conditioned by the school situation. Surveys in firms test, correct and extend the insight and knowledge derived from the individual experiments made in school, through contact with the reality of the world of business and industry. The knowledge and skills obtained from projects and surveys finally enable the pupil to grasp the professional, social and industrial problems he may encounter during practice and to come to terms with them.

5. Pre-conditions and facilities

In the context of the general educational reform programme, progress in the outward re-grouping (i.e. in place and space) of the top classes of the Volksschule into upper level primary schools has varied considerably from Land to Land. The trend everywhere is to combine top classes of schools with a narrow range of courses to form one single upper level primary school (or central or rural comprehensive school) with a wide range of courses. But in the non-urban States problems connected with "external reform" will for years to come hold back any "internal reform" (wider range of courses, nucleus system, etc.) and with it the introduction of new subject matter and methods such as those used in technology teaching. But that will not prevent current progress and experiments from expanding in every Land at the same speed as the "external reform"; it will go on being tested out in a wide variety of regional situations and from the experience gained the foundations of a generally applicable curriculum will be laid within the foreseeable future.

In the City States (Berlin, Bremen, Hamburg) and large cities, facilities for "Arbeitslehre" in upper level primary schools, such as technical rooms (wood and metal workshops, laboratories, kitchens, textile workshops) and equipment (technical tool kits, classroom practice equipment, etc.), are felt by teachers to be adequate. But in rural areas, facilities for technical work are still frequently scanty. Teachers may be forced to make do with anything to hand or to use ill-equipped classrooms or cellars for handwork and domestic science, unless they are able to use technical rooms in neighbouring schools. But even in unfavourable conditions, e.g. in rural schools with a narrow range of courses, a great many open-minded teachers manage to develop teaching models which make use of "out-of-school procedures" (surveys in firms and practice in firms) and which are truly exemplary.

The economics and vocational sector has proved to be one of the weakest points in technology teaching mainly because teachers are still inadequately qualified. Schools television and radio programmes in this field are therefore specially prepared and broadcast by certain corporations (WDR, SR, SFB, and SWF) with the co-operation of teaching experts; receiving sets are available in almost every school. Teachers' manuals (6) and pupils' textbooks (18) are provided with the broadcasts for the purpose of preparation and subsequent penetration.

6. Training and further training of teachers

One of the essential reasons why there is such a variety of Arbeitslehre experiments in the Federal territory is that teachers' knowledge of the occupational, economic and social factors in work and industry vary considerably and may be inadequate. It is generally thought that teachers who have previously had some other profession and who have come to teaching via adult education are best equipped to teach the subject. So generally they were the first to be asked to experiment with Arbeitslehre teaching, or they themselves did so on their own initiative. Some of them have thus already obtained considerable practical experience in teaching the subject and they are being used as advisers on Arbeitslehre in the further training of teachers. But for the time being there are no generally applicable teaching principles in this field, and so further training is limited to separate items of information on labour and industry and the presentation of selected teaching models, which are not sufficiently firmly based on teaching principles and which have not yet been sufficiently well tested in practice.

Under general arrangements for the further training of teachers Ministries of Education or individual educational authorities offer varying degrees of further training in Arbeitslehre. For example, as many systematically arranged courses as possible are being organised in Hamburg and Bremen by the appropriate institutes and in Berlin with the co-operation of the Schools and Industry Working Party. Other Länder (e.g. Hesse, Rhineland-Palatinate) organise weekly courses or courses lasting several days. In Bavaria the third television network is used to familiarise teachers with the requirements of the upper level primary school and the 9th class, without withdrawing them from work. Mention should also be made of the German Correspondence Course Institute (Tübingen) scheme to enable teachers to obtain by correspondence the qualifications needed to teach Arbeitslehre.

Only in a few exceptional cases do Ministries of Education provide opportunities for larger groups of teachers to learn of developments in other Länder or to attend courses and conferences at recognised super-regional institutions; any such arrangements generally entail considerable sacrifices in time and money on the part of those who attend.

Teacher training colleges are proving slow to realise the need to organise special study courses and independent lecturing posts in "Arbeitslehre". So far Arbeitslehre lecturing posts exist only in the teacher training colleges in Berlin, Bremen, Flensburg, Kiel and Saarbrücken. At these colleges Arbeitslehre can be studied by students as their first or second subject. In the training colleges of North Rhine-Westphalia, there are separate lecturing posts for the three technical fields of Arbeitslehre - technical, economic and domestic; but generally there is no joint planning by lecturers in the three fields. In all the other teacher training colleges in the Federal Republic at least individual problems connected with Arbeitslehre are covered within other disciplines (political sciences, sociology, general theory of teaching); there are no plans for special courses in the subject. At most teacher training colleges practice in industry and social work is provided for students on a voluntary basis, but students make relatively little use of the opportunity because practice of that sort generally speaking has no direct bearing on the course or examinations. So there can be no hope that sufficient well-qualified technology teachers will be trained within the next decade unless appropriate measures are taken at once in the field of teacher training and further training.

7. Prospects

A fundamental scientifically established theory of technology teaching and a universally valid curriculum are considered by experts, educational policy-makers and teachers alike to be an urgent necessity for the future development of "Arbeitslehre" in upper level primary and comprehensive schools in the Federal Republic. According to Herwig Blankert (4, page 172, et seq.) costly, time-consuming research is required and at present the means cannot be provided out of the education budgets of the State or the Länder or by private endowment. Resources are not even sufficient to encompass and describe all the current experiments being conducted in schools (1), not to mention vetting them scientifically and

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(1) Apart from a specific survey of technology teaching conducted by the present writer with a grant from the Volkswagen Foundation and the help of the Cultural Research Institute of the Max-Planck Gesellschaft in 1968/69 (pub. 1970) (23).

testing their reliability. All that we know of so far is a control experiment which Friedrich Roth conducted in Frankfurt between 1968 and 1970 on six upper level primary schools to assess the project method in technology teaching (23, Volume 7, p. 76 et seq.), the results of which will probably be published in 1971. We have as yet no information on Lichtenstein-Rother's promised experiments in upper level primary schools in North Rhine-Westphalia (13) or those planned by Wolfgang Klafki on comprehensive schools in Hesse (20, page 73 et seq.).

Despite its lack of secure foundations, the teaching of technology is being introduced with increasing vigour into all the Länder. The curricula and guidelines which have been provisionally proposed should be constantly set against practical experience and revised where necessary. It is to be particularly hoped that experience gained in the field in comprehensive schools will help towards the inclusion of "Arbeitslehre" among the subjects taught in all secondary schools, including technical and grammar schools; for this much is already certain and is proclaimed by all progressive educationists in every part of the Federal Republic - pre-vocational instruction of the "Arbeitslehre" type is no longer a need peculiar to upper level primary schools but is an indispensable part of the "general" education of any young person in every branch of schooling in a modern industrial society.

APPENDIX

Curriculum for 7th Class Metalwork
8th Class Electrical Engineering
9th Class Domestic Science

Sources: 5, p. 8 et seq., p. 41 et seq., p. 58 et seq.

7th Class - Subject: Metalwork

Criteria in planning production for personal use	Teaching 1. Total time 2. Allocation of time 3. Premises 4. Special aids	Teaching objectives Knowledge Skills
Pupils work on articles for their own personal use, designing them themselves, and making their own plan of work, taking account of school workshop facilities and available time. Cost of materials must be within the limits of their pocket money. Pupils gain experience of the qualities of various materials, their own ability to use tools and machines and their ability to produce an article, draw up a plan of work and carry it through.	1. 36 periods 2. Combined periods 3. Classrooms, metal work shops 4. Vocational training aids (films, tapes, slides, booklets)	TECHNICAL 1. Drawings A design of the proposed article is submitted by the pupil in the form of a sketch. It must give as many views as are needed for the exact definition of the article (elevation, section, plan) - perspective drawings are not required. Drawings and measurements are to be done in accordance with DIN (German Industry Norm) standards (measurement lines etc., arrows, figures in millimetres). 2. Materials Pupils become familiar with the different properties of metals - steel, brass, copper and aluminium - in relation to the working techniques mentioned below, and the problem of corrosion. Artificial materials must be sampled and taken into account in planning, as far as possible. In connection with the article to be produced, pupils find out how to select metal bars, shapes, sheets, tubes and/or smaller accessories from schedules and catalogues. Material is selected on the basis of experiment (intended use, appearance) and taking account of cost. 3. Techniques Pupils develop the knowledge and techniques required in carrying out the following operations, i.e. designation of measuring instruments, tools and aids, rules for the handling and care of materials, correct procedure, including accident prevention. Measurements (accuracy ± 1 millimetre) with steel ruler, outside calipers, steel square and try square. Marking out with gauge, steel straight-edge and try square. Screwing up in the vice with accessories (protectors). Sawing with hacksaw. Filing with taper file (specialists blunt file). ECONOMIC 1. Calculation Pupils must make preliminary calculations of costs (main and secondary) comparing costs of different materials. Probable work-time must be estimated. Actual use of materials and time are to be recorded on work slips during execution. In a subsequent calculation the actual facts will be assessed; the plans will be compared with actual execution and deviations and their causes examined. Pupils must be able to define the concepts of calculation, main materials and secondary materials. 2. Supply Establishment of type and quantity of material required. Sources of supply must be established together with type, cost and quality of material (use of relevant sources of information). Pupils weigh up the information obtained and take their own decisions, which must be based on rational criteria. Planning of supply according to source and quantity (e.g. individual or group purchase).

	Supervision	Contributions from other subjects	Contributions to vocational guidance	Alternative processes	Examples of projects (a) Production projects (articles and services) (b) Analytical projects (surveys, practice, case studies)
3. Organisation Pupils make a work plan giving the sequence of all the most important operations (e.g. building instructions). They must use appropriate work slips (partial operation, means, materials, time, special details). Places of work and facilities have to be allocated according to workshop regulations. SOCIAL Regulations for workshop procedure must be di[illegible], justified and agreed. The same applies to any penalties for contravention of regulations. Consideration of various ways of distributing roles for execution of partial operations included in the work plan. Any problems of co-operation or disputes must be dealt with in the first instance by small work-groups. Any unsolved questions may be discussed by the whole work-group in order to facilitate a decision.	Comparison of the product with the design, taking account of the pupil's own evaluation. Criteria: - accuracy in measurement - quality of material - quality of work - appearance Examination of time and cost	Mathematics: measurement of length, right angles, calculation of surface area	Not yet established	Protection of surfaces: varnishing metal burnishing tempering methods of holding together: glue	(a) rail with hooks (key rail) book-ends napkinstand

8th Class - Subject: Electrical engineering

Criteria in planning production for an individual contractor	Teaching 1. Total time 2. Allocation of time 3. Premises 4. Special aids	Teaching objectives Knowledge Skills
Pupils make an individual article, the quality of which is measured against that of hand-made articles on the market. The decision to make the article is taken in agreement with an individual contractor. Planning and execution are done in accordance with production regulations. Model work plans are prepared and established jointly. Pre- and post-operational calculations are done jointly. Price depends on supply and demand in the school context.	1. 36 periods 2. Combined periods 3. Classrooms metalwork shops, if possible with individual lighting for each workbench, seating at work level, 3-pin earthed plug sockets	TECHNICAL (a) Drawings: The task is presented to the pupils in the form of simple standard assembly diagrams, partial diagrams and circuit diagrams. In addition, an example of the equipment is demonstrated (comparison with drawing; workings); pupils, with the teacher, draw up a work plan based on a model plan which they are shown, and they prepare drawings. The objectives set forth for grade one metalwork and circuit diagram norms apply to these drawings. (b) Material: Choice of components, raw materials, semi-finished products and ready-made parts is made taking into account the use to which the article will be put (normal quality), the contractor's wishes and operational procedures (existing facilities in the workshop). Selection can be made from among metals (construction and conducting materials) and artifical materials (construction and insulation materials) most commonly used in the electrical industry. Pupils get to know the qualities of the raw materials in relation to the work procedures mentioned below and their electrical qualities (as conductors, non-conductors, semi-conductors) and their durability (upkeep, corrosion, wear). (c) Work techniques: The list drawn up under criteria for projects for personal use (metalwork) must be extended to include the following knowledge and skills: 1. Insulating of wires with insulating pliers. 2. Tinning of lead ends, soldering with electric soldering iron (220 V/100W). 3. Bending lugs with round-nosed pliers for making electrical contacts. 4. Soldering of electrical connections with the soldering iron (220 V/30W); care of the soldering iron. 5. Connecting/wiring up of electrical components. 6. Pinching for making electrical contacts. Observance of accident prevention measures in force. ECONOMIC (a) Preliminary calculation of requirements in raw materials and secondary materials for alternative methods of execution, comparison of the various methods of execution. Calculation or allowance of an additional amount to cover risks; comparison between own costs and commercial prices. Assessment of work and supervision. (b) Obtaining of customers through inquiries and publicity. (c) Finalisation of material required, sources of supply and tenders. Drawing up of a list of parts and materials. Supply plan according to quantity, place and time. Independent purchase where appropriate. Payment of money orders by post, filling out of receipts. (d) Acceptance and confirmation of orders, filling out of bills, registration of correspondence and vouchers. (e) Keeping a simple income and expenditure account, management of cash and keeping of a cash account book.

	Supervision	Contributions from other subjects	Contributions to vocational guidance	Alternative processes	Examples of projects (a) Production projects (articles and services) (b) Analytical projects (surveys, practice, case studies)
(f) Purchase on account, payment by money order, filling out of receipts. (g) Comprehension of business terms. (h) Planning of work, use of work slips for control of progress; comparison between plan and work; identification and allocation of special tasks, national organisation of the workbench. (i) After-check of raw materials, secondary materials and profits. SOCIAL - recognition of roles and their function in social relationships; - recognition of the roles expected: (a) of the pupil in working from a given pattern, (b) of the pupil by the individual contractor, (c) of the supplier (of materials) by the pupil. - recognition of place, position, status, rank and role as the basic structural factor in the social system; - recognition and fulfilment of role e.g. in applying general rules to specific work situations; - rational behaviour in conflicts of roles; - recognition of causes, possible channels and solutions; - ability to remain aloof from one's role and to pass critical judgment on how it is played (sanctions as the response of business partners).	Test of suitability for its function. Test of reliability. Comparison between the article made and the pattern. Measurements: Quality of work (especially soldering). Appearance. Examination of time and costs.	Mathematics: Measurement of length Measurement of surface area Calculation of cost Measurement of time (proportion, percentages) Physics: Principles of electrical engineering (properties of electricity, voltage, current, resistance, simple electrical circuits, direct current and alternating current). German: Correspondence, Publicity and advertisement, Catalogues and prospectuses.	Not yet established	Tinplating by dipping	(a) Power supply unit - charging equipment for small-size accumulators e.g. for portable radio and television sets, tape recorders and flash equipment. - as source of power for the following projects apparatus with flashing lights - signal apparatus (model railway, model motorway, model airport) - set point control equipment (e.g. thermostats) - door and window security - components in lighting effects (lights for parties, fairy lights etc.) - intercommunication system - intercommunication between 2 points e.g. living room - kitchen, garden gate - front door Light barrier - switching on and off of any desired circuit e.g. lamps, wireless sets, etc. when passing through a light barrier - in connection with an alarm bell for security of rooms Remote control switches manual remote control of any desired circuits e.g. lamps, wireless equipment, from as many places as required.

9th Class - Domestic science

I. Criteria for domestic science projects	Teaching 1. Total time 2. Allocation of time 3. Premises 4. Special aids	Teaching objectives Knowledge Skills
Model plans should show pupils the connection between technical, economic and social considerations. Planning in the home embraces income and expenditure (use of income) planning of gainful occupation and planning of household management. In the 9th class the main emphasis is on organisation and long-term planning of gainful activity and household economy from the finance and time points of view. Thus teaching must show: (a) the connection between occupation and household, work and consumption (establishment of criteria from the domestic science point of view); (b) household and family to be a sector that can be organised in accordance with rational decisions (ability to run a household and plan life rationally); (c) the place and function of the household (single persons, childless families, and families with children) in the social context (ability to mirror social and socio-political conditions).	1. 144 periods 2. 72 periods (full class) 72 periods (half class) 3. Classrooms Rooms for household techniques and textile work, possibly model house. 4. Letters from employers Number Year	I. Household planning 1. Identification of the various types of household (type 1: single person; type 2: 2 persons; type 4: 4 persons) according to income, age and sex, to serve as a basis for all further planning. 2. Realisation of the fixed costs and variable expenditure in different households (household plan). 3. Pupils learn of the various ways of obtaining a house (titles, owner flats, loans for tenants, etc.). 4. Pupils learn criteria for the selection of a house or flat for households of types 1, 2 and 4. Position (communications, distance from place of work, schools, nursery schools, shopping centre, contact centres, parking areas, green spaces). Arrangements (number and size of rooms, connection between rooms, heating, sun, ventilation). Amenities outside the house (central laundry facilities, children's playgrounds, storerooms, hobby rooms and community rooms). Rent and charges, rates and taxes. 5. Pupils are made familiar with information, advice and protection organisations (e.g. New Domestic Economy, Tenants' organisations). 6. Investment calculations for household equipment (use, length of life, acquisition and running costs). Assessment of useful life of household articles. 7. Execution and filing of accounts, receipts, guarantee slips, contracts, instructions for use, forms; long term timetables. 8. Calculation of gain from various gainful occupations outside the household. Assessment of the housewife's activities. Drawing up of short-term and long-term finance plans. Planning of use of income, allocation of expenditure; establishment of sources of finance and methods of saving, comparative calculations on ways of obtaining credit and investing. 9. Getting to know the most important legal aspects of loan and savings contracts; insurance policies (liability, accident etc.); tenancy agreements; family law (engagement, marriage, community of earnings, law relating to young persons, etc.). 10. Rational behaviour as a consumer: - assessment of personal needs according to urgency (insight into the significance of status symbols); - critical assessment of needs inspired by publicity (suggestive and informative publicity) - exercise of discretion towards the market. 11. Aids to rational behaviour by means of consumer groups sharing common interests: - possibility of organised purchaser solidarity; - influence on supply and legislation. 12. Recognition of professional and private roles for the purpose of harmonisation; occupational activity, family situation, family planning, political affiliation, participation in cultural life. 13. Settlement of conflicts of interest: - realisation of and consideration for the need for emancipation of all members of the family and corresponding allocation of tasks.

	Contributions from other subjects	Contribution to vocational orientation	Examples of projects: (a) Production projects (goods and services) (b) Analytical projects (surveys, practice and case studies)
II. Household management (experiments to determine costs and time) 1. Pre- and post-calculation or comparative calculation of household.expenditure for the various types of household (1, 2 and 4), by criteria for time consumption and expenditure. 2. Market survey of goods and services. 3. Pupils obtain knowledge and skills concerning the kitchen as a place of work, i.e. work places and equipment (preparation, cooking, washing up). Arrangement of work places. Relative measurements (DIN 18022, size of the various pieces of equipment). Designs and types of kitchen. Rational selection and arrangement of equipment. 4. Time and motion studies, definition of work routes, planning of work procedures, comparison of various forms of organisation. 5. Calculation of income and expenditure. Management of cash and keeping of a household cash book. 6. Safety in the house. III. Furnishing a flat Pupils plan the arrangement of a flat of types 1, 2 and 4, in relation to living requirements. Furnishing of rooms (basic equipment and possibility of expansion, consideration of places for putting things and space for movement e.g. according to DIN 18011): Material, form and function of furnishing; Decoration (wallpaper, curtains, carpets); Lighting and colour problems; household linen, crockery, cutlery, glass. IV. Drawing up plans for the care, clothing and feeding of babies and small children, hints on education 1. Pregnant mothers - drawing up of rules of behaviour during pregnancy; - collection of information on employment protection and insurance for mothers; - survey of institutions advising and caring for pregnant mothers. 2. Care and upbringing of babies and small children: - collection of a layette for the new baby; - care of the new baby; - drawing up a feeding plan for the first year; - stages in development in the first year; - criteria for choosing practical, safe, appropriate toys; - symptoms of illness in babies and small children and rules of conduct for parents; - sources of danger to babies and small children and first-aid in case of accidents; - compulsory and voluntary vaccination (effects and reactions), notifiable diseases. 3. Familiarisation with literature on the upbringing and care of babies and small children. 4. Occupations connected with the welfare and upbringing of children and the tasks involved.	Sociology: 9.21 Past and present function of the family. 9.22 Position of woman in industrial society. 3.23 Social assistance from the State, the community and welfare associations. 2.24 Family laws. 8.00 Man as a consumer in economic society. Biology: (Sex education)	Not yet established	(b) drawing up of household plans for household types 1, 2 and 4. Obtaining and financing a house or flat. Household management. (a) (b) Furnishing a house or flat. (b) Drawing up a plan for the care, clothing and feeding of babies and small children. Hints on upbringing.

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COMMITTEE FOR GENERAL AND TECHNICAL EDUCATION

THE TEACHING OF TECHNOLOGY IN FRANCE

by

A. PAYAN

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THE TEACHING OF TECHNOLOGY IN FRANCE

I. Structure and organisation of the French school system

I.1 Compulsory primary education begins at the age of six and extends up to the age of eleven - or occasionally twelve in cases where pupils have repeated a class. Optional pre-school education for children from two to six years of age is provided in nursery schools.

Vestiges of the old "pre-reform" system still remain in the form of primary school-leaving classes composed of pupils in the twelve to fourteen age-group who complete their studies in a two-year terminal course.

I.2 Lower secondary education

The various types of secondary education which existed under the old system are progressively being replaced by a unified system which is more logical, more democratic and provides equality of opportunity for all. Uniformity is being achieved by the abolition of first cycles in the technical lycées; by the gradual closure of those sections of the technical colleges - which draw pupils from the primary school-leaving classes (twelve to fourteen), themselves disappearing now, too; and by the conversion of the junior secondary departments in the classical and modern lycées and CEGs (1) (providing short courses) into CESs (2) enjoying administrative, educational and financial independence.

Consequently, all pupils between the ages of eleven and twelve leaving the terminal class of primary school (i.e. the second year of the intermediate course "cours moyen") will proceed to a CES for a two-year "observation cycle" in their sixth and seventh years of schooling, which under the French system are rather illogically called Class 6 and Class 5.

This cycle constitutes a common course for all pupils, the sixth and fifth "transition" classes providing specially adapted instruction for those who, by traditional standards, are for different reasons slightly retarded, i.e. from the point of view of their attainment in the two basic subjects (French and mathematics) and the two "stimulus" subjects ("matières d'éveil")(history - geography and natural sciences).

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(1) Collèges d'enseignement général.

(2) Collèges d'enseignement secondaire.

In the CESs there is, in addition, a guidance cycle also lasting two years. It is in the first year of this cycle (Class 4 or eighth year of schooling) that pupils begin to follow different paths and technology is introduced (see II).

In this class a distinction is made for the first time between:

- basic compulsory subjects including, French, mathematics, the first modern language and technology;
- compulsory "stimulus" subjects including history, geography, natural sciences, handicrafts, art and physical education;
- optional subjects including Latin, Greek, a second modern language and intensive study of the first modern language.

In the following year (Class 3 or ninth year of schooling) the teaching is similar to that of the previous year and completes the guidance cycle. The conclusions reached at the end of this cycle are decisive for the pupils' future.

I.3 Upper secondary education

From lower secondary education pupils proceed:

- either to a short upper secondary course, with a vocational bias: pupils study for two years in the new secondary technical schools ("collèges d'enseignement technique") and prepare for the vocational training certificate ("Brevet d'Enseignement professionel");
- or to a long upper secondary course offering economic, technical, literary or scientific studies. This three-year course leads up to the baccalauréats which permit admission to higher education where, once again, there is a choice between a short course in the institutes and a long course in the universities. It should be mentioned that any pupil or student taking a short course can, on completion of this course, transfer to a long course.

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II. The teaching of technology

II.1 History and background

The introduction of the teaching of technology in France can be attributed to the foresight and determined efforts of the Directeur Général, Monsieur CAPELLE. The subject was first introduced experimentally in technical schools in 1963, with the co-operation of technical teachers.

Once an idea has been created, it needs a favourable climate in which to develop. That this climate existed can be illustrated by numerous quotations expressing the concern shown not only by specialist teachers, but by educationists of every kind.

> "Manual work and learning-by-doing (replaced by initiation into technology) can also prepare the pupil for technical and scientific studies which occupy too small a place in our schools. This state of affairs, inherited from the dead past, must be rectified without delay."
>
> - Unesco document -

> "Secondary education must itself comprise technology courses and their graphic expression in order that every pupil may be able to integrate himself with the technical world we are living in, whatever may be the level at which he leaves school."
>
> - Unesco document -

A far cry from the formal parting of dogma by the teacher, technological studies will be focused on the technical object.

> "The technical object, more than the scientific object, can play the part of a mediator between nature and man, because while the scientific object reveals itself as analytical, abstract, even creating a sense of irreality, the technical object is seen to be synthetical, concrete and in direct relationship to nature. It organises different sciences starting from a finality which has been lived and which gives it a kind of deep unity. It brings together intentions and laws."
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> - Unesco document -

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> "Are our education systems - inherited from the not-too-distant past when education was the preserve of relatively limited groups of people within a relatively stable society - suited to today's need for mass education and to a world undergoing rapid intellectual and material development? In the face of the explosion of scientific and technological knowledge, and of the profound economic and cultural changes which are taking place in traditionalist and modern societies alike, can we leave the structures, curricula and methods of the past just as they are?" (1)

- René MAHEU, Director General of Unesco -

- Rabat Conference -

> "Teaching based on what is real and concrete could be very helpful to children from humble backgrounds during their first stages of secondary training."

- Rapport sur la Jeunesse - France -

and again in the same report:

> "If a statistical connection can still be found between success at school and social origin, it is mainly because the education system itself was conceived and developed for special types of intellect and can be assimilated only by those who have the necessary basic knowledge. Too often there is confusion between aptitudes and initial intellectual acquirements." (1)

The discovery of aptitudes involves the process of communication and where this is inadequate real capabilities may remain undetected. In spite of its bluntness and political overtones, we should like to recall the conclusion reached by the Italian Professor, Director of the Barbiana School on "true culture";

> "It is inaccessible to the rich, because they are cut off from the masses, and to the poor, because of the absence of communication."

Moreover, if our concern is to train scientific minds, capable of discovering and revealing causal relations, we must admit that this act of discovery is, in itself, a kind of article of faith and that the complexity of reality does not facilitate its analysis. Is this an explanation or a justification of the gulf that too frequently divides school and life? Common objects must be specially treated before they find a place within the "hallowed precincts" and even scientific objects are subjected to a process of intellectualisation, and rationalisation in which pupil participation is all too rare.

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(1) Translator's version.

The imparting of knowledge remains a craft which we have devised, and if our pupils progress along the path of discovery it is mainly in our wake.

Technology has attempted to provide a solution to all these contradictions and problems.

II.2 Definition of technology

In the context of what has just been said, Monsieur CAPPELLE defined technology in the following terms:

- "Education Nationale": "L'option moderne s'enrichit".

II.21 Technology is a language

"... like mathematics, technology in lower secondary teaching, since it is based on a mode of expression, the dimensioned drawing, with its conventions, rules and logical combinations, is also a language: a language making it possible to study and know the mechanical activities, which are considerable today, of our civilisation."

II.22 Technology is a subject concerned with construction

"Technological language, expressed by the dimensioned drawing, finds its applications in activities of analysis and synthesis starting from objects - machines, for example - conceived by man to satisfy his needs ... Mechanical entities offer (by comparison with biological entities) obvious advantages: they are much simpler; one may choose among them the elements of a progression easily achieving the transition from the simple to the complex ... Moreover, while analysis is relatively easy in both cases - disassembling or dissection - synthesis, on the other hand, is much easier in the case of mechanical entities ..."

II.23 Technology is a science

"Technological reasoning coincides with scientific reasoning: one starts from objective consideration, one advances by a system of successive trials, one finally reaches a general view of the phenomenon analysed, sometimes a law ... Technology, through its methods of analysis and synthesis, is therefore capable of establishing bonds between physics and mathematics, and awakening the curiosity and aptitudes of pupils to the immense field of the experimental sciences."

II.24 Technology is a means of culture

Moving on from these pedagogic considerations, and indicating the true place of technology among the other subjects which have for many years figured in our curricula ...

"Technology is a means of culture in the sense that Valéry understood it, that is, a means of situating oneself in relation to the modern world, in the technical and human aspects which characterise our civilisation."

II.25 The aim of technology teaching and its medium

Technology as a school subject was previously optional, but will be compulsory (see para. 12) as from October 1970. To comply with the definition given above, it will be centred on a technical object, that is, some object designed, developed and manufactured by man to fulfil a specific purpose.

For teaching purposes, the object chosen will be:

- sufficiently simple for its purpose to be obvious;
- a well-known common object so that the pupils can write and talk about it readily without the help of the teacher.

The truth to be discovered about this object should, above all, be obvious and should require no more than the perception of the relationship between the various parts of the whole.

For psychological reasons, the object will be:

- mechanical, because children generally (and particularly those in the thirteen to fourteen age-group) are interested in movement and are keen to study relationships within objects that move. The motivation is obvious, and the teacher acts merely as a catalyst and an organiser of living research.

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III. Brief analysis of the syllabus

The essential topics are the two elementary functions: translation and rotation. To these are added transmission and transformation of motion to make the syllabus more complete, and to satisfy a curiosity which we witness every day and penetrate the complexity of reality. These topics form part of the study of elementary kinematics whose analysis, in addition to the logical reasoning which we emphasised earlier, calls for:

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- diagrammatic representation of an abstract concept which strips the object of its tangible qualities and reveals its elementary function and essential internal relations;
- measurement and observation of their numerical expression which, carried out accurately, form the basis of all scientific work;
- graphic representation of the measurements and their analysis;
- mathematical interpretation of the graph;
- the dismantling and reassembly of the object which requires the ability to pick out from the whole co-ordinated unit the main parts, the secondary parts and their connections, and involve both logical thinking, mechanical intuition and manual dexterity;
- the child's creativeness and inventiveness applied to concrete objects with results that can be immediately checked. (This opportunity is so rare in education that I feel it should be emphasised.)

and also

- graphic expression.

I shall not dwell on the qualities required and the aptitudes developed. In spite of the limits quite justifiably imposed by the time-table and official instructions on the "apprenticeship" in this subject, it can be asserted that this "language", which is increasingly essential to 20th century man living in a technical civilisation, is of great value during this guidance cycle when aptitudes are being discovered and vocations aroused. To quote Teilhard de Chardin "whether we like this fact or deplore it, nothing more surely or more exactly characterises modern times than the irresistible invasion of the human earth by technology".

By its choices, content, context and pedagogy, technology aims to break down the artificial barrier of prejudice between the two cultures - the arts and the sciences - and we hope thereby to encourage better recruitment for technical education in order to meet the need for a more rational distribution of skills which the nation requires.

III.1 Class 4

I shall confine myself to the introduction and the four chapter headings forming the syllabus "Technology and Physics-Mechanics". The list of objects to be studied is given as a guide, and judicious selection by the teacher should provide a method of analysis which will bring out the technical functions and their logical organisation. The method of analysis leads on to graphic expression, measurements, and consequently, the problems of indicating dimensions or values. Only elementary dimensioning will be taught.

The free choice of objects should enable the elementary technical functions to be introduced:

- attachment
- guiding
- motion and transmission of motion.

It should also permit the introduction of the following concepts in physics-mechanics:

- measurement of length and arcs (angles)
- concept of force, weight and mass
- friction between solids.

It is clear that a technical object, however simple, cannot illustrate one phenomenon only and the distinctions below are made according to the dominant feature.

I. Study of a technical object selected from a group of objects involving the principle of translatory motion.

II. Study of another object from a second group whose construction calls for precision, in order to introduce:

  - the systematic study of guided translation,
  - the concept of linear measure,
  - elementary functional dimensioning.

III. Study of a technical object from a third group comprising elements, the deformation of which, produced by stress, can be measured to facilitate comprehension of an abstract concept: force.

IV. Technological study of a measuring instrument: scales.

For readers who are familiar with the report on the course "Technology teaching in lower secondary education in France", held at the International Centre for Pedagogical Studies at SEVRES in France, from 11 to 17 October 1968, it is important to mention and explain the differences between that report and this paper.

Earlier conceptions virtually limited study to the kinematic aspect revealed by technical objects. In the sense that motion cannot exist without force, we were imposing, in a very arbitrary fashion, a system of study in keeping neither with reality nor the pluridisciplinary nature of technology. Despite the choices necessary in any study in order to avoid popularisation or the mere satisfaction of curiosity, we have sought to reintroduce, from Class 4 onwards, the "physics" of the phenomena studies and, in particular, the problems of measurement and the concepts of force, weight and mass. These concepts, which are inseparable from the concrete objects from which they emanate, are thus given due prominence in our syllabus.

III.2 Class 3

The important items of rotation, and the transmission and transformation of motion could not be included in the Class 4 syllabus. They will therefore constitute the first part of the Class 3 syllabus, the final draft of which is currently being examined by a committee of experts, but transmission will be confined to the study of gear-wheels, and transformation to screw-nut and rack-and-pinion systems, which involve the use of two measuring instruments based on different principles: the screw-type micrometer (generally for elongation) and the dial-type comparator (generally for deviation). This syllabus reflects its author's desire to return once more to a field common to technology and physics, that of measurement, its limitations and quality.

The second part of the syllabus will still contain, but in simplified form, a chapter on electricity covering only the study of simple circuits and their standardised description. The main units of measurement of electrical currents will be given (voltage and strength) and safety regulations for the protection of the user and the plant itself will be indicated. An item of household electrical equipment will be studied technologically and experimentally and pupils will be required to read and interpret the particulars given by manufacturers on common appliances (power, voltage). The concept of electrical energy and the reading of a meter will be among the subjects dealt with.

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III.3 Implementation of the syllabuses

The extension of technology to all sections could be obtained only by cutting down on the time allocation: this is fixed uniformly at two hours per week only, but in compensation:

- technology is established as a basic, compulsory subject common to all courses. It will be taught by one teacher who will be required to bring out the kinematic and physical aspects of the object studied and express these in the form of a logical table, a technological diagram, a graph expressing the results of measurements, a mathematical relationship, and an industrial drawing fulfilling the most elementary standards for marking dimensions.
- the number of pupils will be cut down to that for practical lessons and will generally be under twenty, with an average of about sixteen.
- no distinction will be made between boys and girls and the classes, which will generally be mixed, will thus be characterised by a strong, stimulating competitive spirit.

These are major innovations reflecting a considered educational policy and designed to compensate the reduction in time allowance.

Note should be taken of the deliberate wording in the Class 4 syllabus: study of an object selected from one group ...

The use of the indefinite article indicates that only one object will be studied, but it also implies that teachers are free to select, from a list which is merely a guide and not exhaustive, a particular object from the group which they intend to study in its entirety. It is obvious that if the study is confined to one object, it will be easy to establish analogies and to make comparisons from which the characteristic of the group can be deduced.

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IV. Buildings and equipment

IV.1 Buildings

I think it is worth repeating that, in spite of the presence of the technical object and the fact that it has to be handled, dismantled and reassembled, technology in French

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education is not a workshop subject and this fact determines the structure of the teaching rooms. These should also meet the requirements of a school unit - or monomer, to borrow a term from chemistry - of between 600 and 700 pupils. This would correspond to an average of four to five fourth-year classes and a similar number of third-year classes, with about thirty to thirty-two pupils in each. For the technology lessons, these classes would be divided (see III.3) in two to form eight to ten groups in both years, each requiring sixteen to twenty hours' instruction. Two full-time teachers and two technology rooms would thus be needed. For time-table purposes, it is desirable that these two rooms should be interchangeable; we are thinking in terms of a multi-purpose room which could be used at any stage in the syllabus and for any type of lesson. The two technology rooms, 7 x 10.5 metres, should be located on either side of an equipment room 7 x 7 metres and placed at an angle to the laboratory benches fixed to the two long sides of the classroom. Each bench should be provided with the necessary gas, electricity and water supply fittings controllable by the teacher alone. The teacher should have a fully equipped bench facing the pupils to enable him, if necessary, to carry out experiments which are too difficult for the pupils, or set up demonstration models. He would obviously have a large blackboard or other type of board with a screen which could be lowered for projecting films, slides or transparencies. His audio-visual aids would be either projectors or overhead projectors.

IV.2 Equipment

There is a wide variety of equipment available to the teacher and pupils:

- technical objects. For example, a flat door-bolt, a sliding bolt, a latch, a lock, a punching machine, parallel vice jaws, a fruit stoner, a door-stop, a bicycle pump, etc., used in studying translation under the Headings I, II and III (see III.1). The study of rotation calls for the use of pullies and various types of wheels; cog-wheels, which can be examined separately or assembled in a reduction gear unit or gear-box, etc.

  Class 3 requires the technical equipment necessary for making simple circuits, a pocket torch, a bicycle dynamo, a household electrical appliance. As stated, the list is not exhaustive and, in addition to the technical objects supplied to the school as a guide by the Ministry of Education, each school has an allocation which the teacher can use to supplement his collection for his own teaching purposes.

- measuring devices used occasionally as technical objects: for example, rulers sliding calipers, dynamometers and scales, micrometers and comparators. One could also add standard slip gauges, limit gauges, protractors, etc.

  Mention should also be made of the main measuring instruments used for electricity: ammeters, voltmeters, power meters, oscilloscopes.

  To eliminate any danger, the current is supplied through individual fittings to the pupils' tables and is available at 24, 12 and 6 volts D.C. or A.C. with a maximum wattage of 120.

- teaching or demonstration apparatus, consisting mainly of models designed to explain a complex technical object or to illustrate one of its characteristics; many of the models will be built by the teacher himself.

- equipment necessary for the chemistry side of the course; this includes the usual laboratory glassware and basic chemicals, and also technical objects such as Bunsen burners, blowpipes, etc., an internal combustion cylinder, etc., and thermometers for reading temperatures on the Celsius scale.

- simple dismantling and assembly tools supplied to the pupil and forming his own collection.

- finally, the teacher will have a good range of tools and small machine-tools for making the models mentioned above.

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V. Activities related to technology

The importance (which we consider vital) of technology in pupil guidance (see VII) brings it into contact with many subjects calling for verbal expression, observation, visualisation of space and abstract concepts, manual dexterity. I have already mentioned French, natural sciences, mathematics and art (drawing). However, there is one particular subject which is directly linked with technology, namely handicrafts, which are taught one hour per week to groups of the same composition as for technology.

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The observation of the technical object and its design could be supplemented by the actual construction of the object, or part of it. This would "complete the circuit" and enable us to check immediately the quality of the preceding phases. This third, or practical, phase - which could not be included in the two hours allotted to us - could be made very meaningful through co-operation between the technology and handicrafts teachers. We consider such co-operation to be of primary importance and believe that the weekly hour allotted to the handicrafts teacher will enable him to round off the technological training of our pupils.

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VI. Initial and in-service training of teachers of technology

VI.1 Definition of the problem

The introduction of the compulsory teaching of technology will affect about 460,000 fourth-year pupils in our secondary schools. At present the number of properly trained practising teachers is sufficient for 160,000 pupils (hither optional, technology teaching will become progressively compulsory as staff and equipment become available). We therefore need to train teachers for 300,000 Class 4 pupils divided into groups of a maximum of twenty, which means 15,000 groups requiring 30,000 hours of teaching. To simplify calculation, we will assume that the requirements for Class 3 will be the same. Consequently, 60,000 hours of teaching will need to be provided with a specified period of time.

Under the French school system there are two types of teachers, the "lycée type" possessing a secondary teacher's certificate (CAPES: certificat d'aptitude à l'enseignement secondaire) and the "CEG type" teaching in the general education colleges (collèges d'enseignement général) which in some cases may be integrated with the secondary education colleges (collèges d'enseignement secondaire) (see I.2). This second group of teachers will provide about a third of the instruction, i.e. 20,000 hours; the dual qualification required of them will necessitate the training or re-training of approximately 2,000 teachers. The first group will be required to teach 40,000 hours, which will also mean a minimum of 2,000 new teachers. Such, then, is the problem to which there is clearly no immediate solution.

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VI.2 CEG teachers

For several years the training of these teachers in the "Centres Académiques" has included a thorough practical and theoretical basis for teaching technology, but the output of new teachers (300 per year approximately) means that earlier graduates, trained solely for teaching physics and chemistry, will need to be retrained. These retraining courses, encouraged by the General Inspectorate, are being organised by the "Inspecteurs d'Académie" or by departmental inspectors with the assistance of teachers of technical subjects and a number of physical science teachers. Organised on a voluntary basis, the courses are particularly effective, but they need to be developed in the light of the experience gained so far. They include courses in drawing and technology (totalling 100 hours) and discussions on teaching methods.

VI.3 Lycée teachers

Since the beginning of the 1968 academic year (ministerial circular of 11 June 1968) all new physics teachers are given a course in technology during their professional training year, that is, between the theoretical and the practical examinations for their teaching certificate. This 80-hour course is inadequate from the point of view of theory and includes virtually no instruction in teaching methods. Moreover, it does not prepare the future teacher for his role as a guide, to which we shall return in paragraph VII. We envisage a minimum of 150 hours, probably spread over two years, leading up to a theoretical and practical examination to be included in the physical science teacher's examination which would be changed to "Certificat d'aptitude professionelle à l'enseignement de la technologie et des Sciences Physiques" (certificate for the teaching of technology and physical science).

VI.4 Length of the transitional period

We think that it would be unrealistic to spread the training and retraining programme, and we are considering a four-year plan covering the period 1970-74; we earnestly hope that this time-limit will be respected.

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VII. Assessment of results and research

VII.1 Results

I shall make a distinction between the results as they affect the teachers and as they affect the pupils.

VII.11 - In the course of my many visits I have often talked with the teachers. Generally speaking they are increasingly interested in a subject which initially was unfamiliar to them. Physics teachers are discovering the connection between technology and physics and thereby improving their own knowledge. They are discovering the value of the diagram and the drawing, and the influence on their teaching of the active methods - observation, analysis and study of a particular object - employed in technology classes.

VII.12 - The pupils are of very different levels and it is remarkable that all of them are so keen on technology that they find the two-hour period short. For the first time in their lives, perhaps, they feel that they are contributing a personal grain of knowledge and finding a solution whose validity they can check. They can handle a familiar object and rediscover it; they can apply a geometrical relationship. This kind of work becomes a fascinating game, and the main problem for the teacher is to go beyond the game stage, beyond the facil satisfaction of curiosity, and elicit the effort needed for reasoning and for interpreting what is observed. In this atmosphere of activity the pupil behaves in a natural way and his innate abilities can be readily perceived by the skilled observer. Technology constitutes, in itself, the battery of tests necessary for pupil guidance - we shall deal at greater length with this essential feature in the next paragraph (VII.2) - but without any external prompting, the pupil in the technology class undergoes a profound change in his motivations.

- As an exception we conducted experiments with technology in the classical sections where Latin is studied. The results obtained were very satisfactory: the teaching of this subject arouses an interest in things scientific and technical which will be useful in pupil guidance.

- The pupil in the "modern" sections makes real contact with the technical world and spontaneously, without any analysis of his abilities, decides to continue his studies in the technical lycée. This phenomenon is very noticeable and fulfils one of the set aims (paragraph III preamble).

- Finally, it is quite impossible for complete failures to occur in technology because the possibilities are so numerous. But quite frequently there is unexpected success for the pupil who is considered to be mediocre. I need not emphasise the psychological value of such success and the shedding of certain inhibitions which goes with it - consequences whose beneficial effects may be transferred to other subjects - but above all there is a positive opening towards a career.

VII.2 Pedagogical research

To conclude this paper I should like to mention the research initiated and directed by me at the Académie d'AIX. Two people are in charge of the project: a highly experienced psychologist who is responsible for a course at the University of AIX on the psychology of the adolescent and also teaches at the Marseilles Institute for Human Biometry, and a Director of Physical Sciences and Technological Studies who is in charge of the training and retraining of technology teachers. They are assisted by a team of teachers and guidance counsellors whom they call together periodically to discuss and determine the lines to be followed. The results already obtained are encouraging, and it is planned to extend this research to the Académies of Bordeaux, Paris and Strasbourg. I am enclosing for information (Appendix I) the mark-sheet which each teacher is asked to complete in the course of the year for each pupil in his class. The headings are defined more fully in Appendix II. When preparing each lesson the teacher decides which phases will enable him to discover the abilities numbered 1 to 15 or, more likely, in the course of a single lesson, half of these. During the lessons he concentrates his attention on four or five of his pupils and fills in the observation form after the lesson. In the course of the year this form will have been used approximately eight times for each pupil and the fifteen headings will have been examined at least three times, thus providing the teacher with a very full guidance dossier.

There are many questions for which objective answers cannot yet be supplied, for example: comparative behaviour of boys and girls, effect of mixed classes, advantages of using simple or more complex technical objects, effect on future guidance and intellectual development, etc. We hope that the current research will provide an answer and help perfect the guidance procedures at the end of the lower secondary course.

A. PAYAN

Inspecteur Général de l'Instruction Publique
(General Inspector)

APPENDIX I

RESEARCH TECHNOLOGY

PSYCHO-PEDAGOGICAL OBSERVATION SHEET

MARSEILLES
(19.. - 19..)

Pupil .... Date of birth .... Class .... School .... Teacher ....

	1st period from	2nd period from	3rd period from	4th period from	5th period from	6th period from	7th period from	8th period from	TOTAL
	to	to	to	to	to	to	to	to	
INTELLIGENCE AND APTITUDE 1. Aptitude for observation and measuring									
2. Sense of space and geometrical forms									
3. Sense of mechanical functions and relations									
4. Sense of abstract relations									
5. Inventiveness and constructive imagination									
6. Ability to react to a new situation									
7. Manual dexterity									

	1st period from	2nd period from	3rd period from	4th period from	5th period from	6th period from	7th period from	8th period from	TOTAL
	to	to	to	to	to	to	to	to	
MEANS OF EXPRESSION 8. Ability to draw diagrams									
9 Ability with symbols and drawing conventions									
10. Aptitude for correct verbal expression									
PERSONALITY AND CHARACTER 11. Technological curiosity									
12. Enthusiasm for work and sense of initiative									
13. Perseverance in research and application									
14 Intellectual integrity									
15. Desire for perfection in work									

Comment on the total and general assessment by the technology teacher

MARSEILLES, 19..

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APPENDIX II

DEFINITIONS

A. INTELLIGENCE AND APTITUDES

1. Aptitude for observation and measuring

Interest in the object, attention, method in observation. Sharpness and accuracy of observation and measurements.

2. Sense of space and geometrical forms

Ability to visualise the object and its components in space and to represent the shapes accurately. Ability to carry out the reverse process in reading a drawing.

3. Sense of mechanical functions and relations

Aptitude for functional analysis of the object and for synthesis, before or during dismantling or reassembling.

4. Sense of abstract relations

Ability to think in the abstract and generalise from a real situation or object; awareness of relations between numerical results and sense of the physical law or mathematical relationship.

5. Inventiveness and constructive imagination

Aptitude for the process of rediscovery. Sense of making utmost use of available means. Resourcefulness in imagining appropriate solutions.

6. Ability to react to a new situation

Speed of reaction (correct) to the unexpected in observation and reasoning.

7. Manual dexterity

Dexterity in handling the object and producing a drawing.

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B. MEANS OF EXPRESSION

8. Ability to draw diagrams

Ability to grasp the essential and represent it in a simple and intelligible fashion.

9. Ability with symbols and drawing conventions

Aptitude for the language of drawing and the use of symbols. Acceptance and comprehension of the rules of standard technical drawing.

10. Aptitude for correct verbal expression

Ability to present observations and explanations clearly and simply, using correct terms and flexible constructions.

C. PERSONALITY AND CHARACTER

11. Technological curiosity

Interest in the technical environment. Curiosity about technical solutions for various needs.

12. Enthusiasm for work and sense of initiative

Spirit of enterprise; desire to take initiative; desire for achievement.

13. Perseverance in research and application

Will to succeed; sense of sustained effort; eagerness.

14. Intellectual integrity

Scrupulousness in reasoning, measuring and calculation.

15. Desire for perfection in work

Care taken in carrying out the various operations, for example in reassembling the object, making models, and carrying out experiments. Neatness of drawings and exercise books.

APPENDIX III

PEDAL OPERATED DOOR-STOP

Teacher's scheme of work
by P.J. Chirouze

PRELIMINARY REMARKS

- The lesson is given in Class 4 (pupils aged thirteen to fourteen).

- The pupils have been studying technology for approximately two months and have examined various small objects involving the principle of translation, e.g. flat door bolt, sliding calibre, "fruit stoner", punch, etc. They have so far done six to seven simple drawings.

- The choice of a door-stop illustrates fairly clearly the aims pursued in the teaching of technology. Knowledge of this device is obviously of limited importance from both the theoretical and practical points of view. Its study is justified solely by the exercises connected with it (hence the importance of the careful preparation of such a lesson).

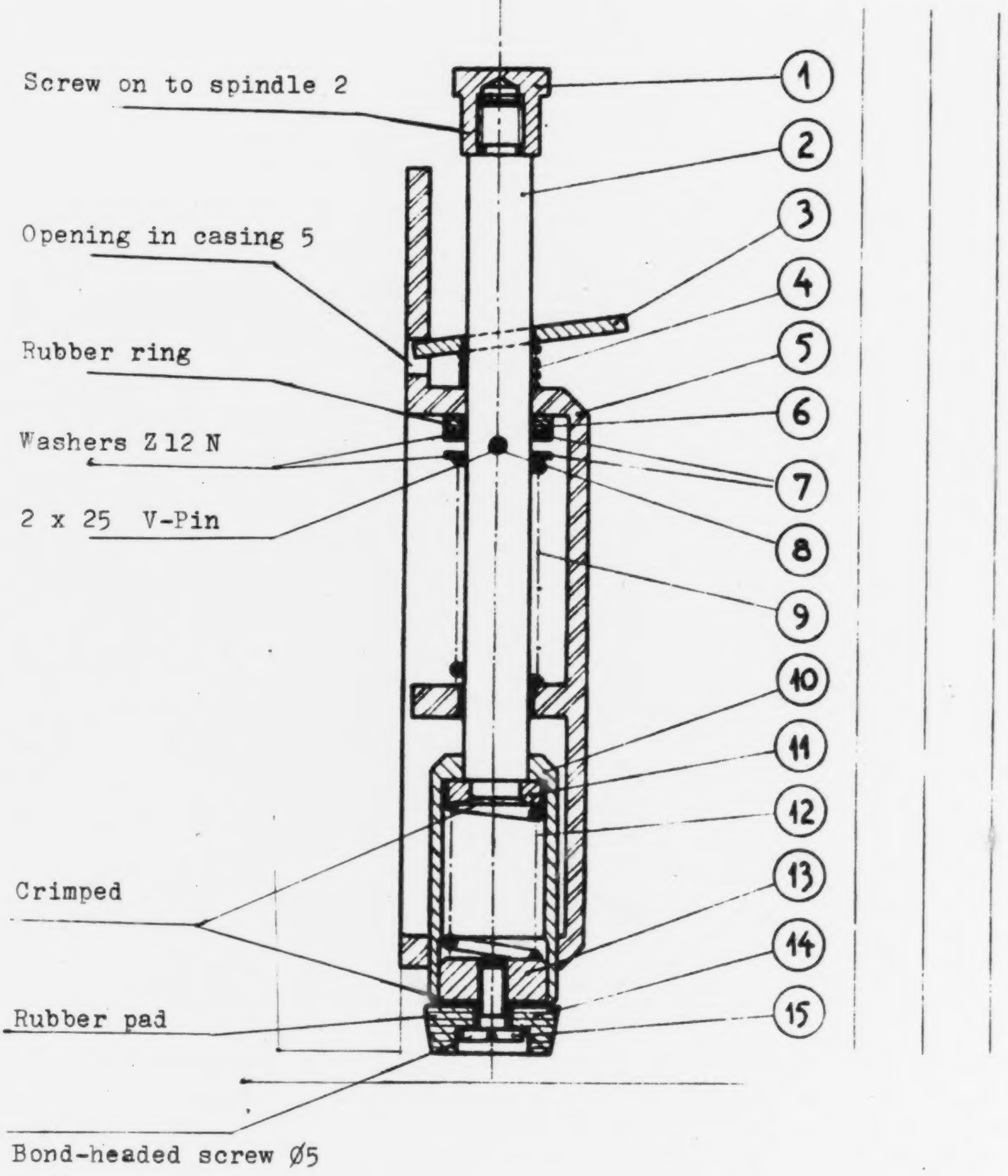
- A variety of exercises can be devised depending on the approach adopted; for example:

A. Exercises based on the object itself.

B. Exercises based on a need or on a problem (variant of the previous lesson).

C. Exercises based on the drawing (complement to the previous lessons).

In this document we shall confine ourselves to lesson C. Readers requiring fuller information may consult a booklet published in October 1968 by the Regional Centre of the Académie of AIX entitled "Technology Lessons for Class 4 Pupils". The booklet is written by P.J. Chirouze, Director of Studies at the Regional Centre of Aix en Provence with an introduction and psycho-pedagogical commentary by P. Juif, Director of an "Ecole Normale".



"GIRSTOP" DOOR-STOP

Scale : 1

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C. EXERCISE BASED ON THE DRAWING

The object of the lesson is to study a mechanism from a drawing.

The drawing shows a door-stop ("Girstop" make) of a rather more complex type than the one used in previous lessons (ETF make). The lesson is therefore an exercise in reading the drawing. It follows logically and rounds off either lesson A or lesson B.

We suggest the following procedure:

I. PRESENTATION OF THE DRAWING (first complete cross-section studied by the pupil)

- What does it represent? (read the inset); what is the scale?
- This is a cross-section: how can you tell? (shading);
- Why was a cross-section necessary? (casing over hollow parts).

We have already studied the simple cross-section of a component part; what you have in front of you is the cross-section of an assembled unit.

The diagram gives only one view and thus it is impossible to define all the component parts fully. However, it shows their relative positions, their relation to one another and the way each one contributes to the working of the whole unit.

How can the various parts be distinguished? (Reference numbers, direction of the shading).

Is the shading identical everywhere? (Standardisation).

N.B. (May be brought in later) The cross-section cuts through the axis of the spindle: has the shading been omitted? (The convention is not to show a longitudinal section of a solid part.)

II. INDIVIDUAL INTERPRETATION

1. The pupils are asked to study the drawing of the door-stop and compare it with the one studied earlier.

   - Similarities and differences are noted on the blackboard.

- This exercise calls for observation and imagination (discovery of shapes and movement). It is made easier by the study of the object itself in the preceding lesson.

2. Correction:

(a) Similarities:

- Same principle used: rubber pad guided in translation.
- Looking obtained by the principle of wedging.
- Automatic release.

(b) Differences

- Addition of spring No. 12.
- Pad fastened by means of screw.

3. Conclusion

The essential difference is the use of a third spring:

Who has understood its function? This will be revealed by a study of how it works.

III. STUDY OF HOW THE DOOR-STOP WORKS

Firstly, on the drawing mark lightly in pencil the bottom of the door and the ground (to simplify matters the bottom of the pad is level with the bottom of the door).

1. Operation

Let us imagine that:

(a) The foot is pressed vertically on part No. 1: what happens? Mark on the drawing the parts which move, (+), those which change shape, (-) and those which remain fixed, (o).

- Before the pad touches the ground (column 1).
- After the pad touches the ground (column 2) ignoring change of shape.

	- Reference No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Signs	- Before	+	+	0	0	0	+	+	+	-	+	+	+	+	+	+
	- After	+	+	0	0	0	+	+	+	-	0	+	-	0	0	0

(b) The foot movement is stopped, what happens? The stop is locked in position.

(c) The foot is pressed on the pedal (3). The stop is released.

2. Diagram showing operation (Figure 8)

(a) Show what the purpose is: show how the door-stop works, ignoring the details of construction. In the diagram we have selected the lower position (with the door held in position).

(b) Assist the pupils with this difficult exercise.

- Begin the diagram on the blackboard (draw the door, the ground, the pad)
- Check the work as it progresses
- Make comments.

(c) Ask for the exact position of the stop (8) in relation to the top of the casing. Let the pupils find it themselves. Correct (C = a + b).

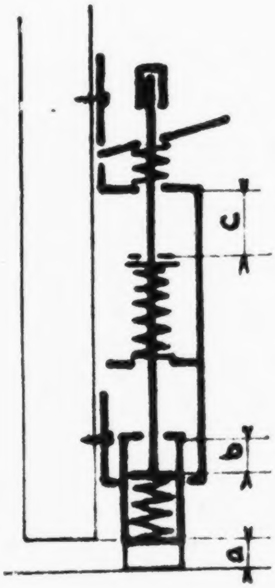

Fig. 8

3. Checking

Add reference marks to the diagram:

The pupil will be required to indicate the function opposite the mark.

4. Guiding of the moving parts

- Before contact with the ground.
- After contact with the ground.
- Justification for the large amount of play in the intermediate space (it does not form part of the guiding mechanism so sufficient play is allowed to avoid the problem of centering).

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IV. NAMES OF PARTS

This exercise is not indispensable: however, it familiarises the pupil with the technical vocabulary and may add interest by the use of a term which suggests its function. For example,

1. Control pedal. 2. Spindle. 3. Release or locking pedal. 4. Locking spring. 5. Casing. 9. Return-spring. 10. Cylinder, socket. 11. Piston ring. 12. Pressure spring. 13. Cylinder bottom. 14. Pad.

V. PLAN FOR ASSEMBLY

The pupils may be asked to do this exercise even if the object used in lessons A or B had not been dismantled. Generally, the pupils are interested in it, and it is a good subject for reflection calling for a variety of aptitudes: imagination, method, sense of space, ingenuity. It is also a very revealing test.

The pupils assume that the sixteen parts are placed in front of them and they have to imagine the successive steps for assembly, noting them as they go along.

A system of symbols is adopted: the system given below is quick, clear and enables a quick check to be made to ensure that no part is forgotten. (Count the number of reference marks.)

a = 2 + 11 (rivetted)

b = 10 + (a) + 12 + 13 (crimped)

c = (b) + 14 + 15 (screwed)

d = 5 + (c) + 9 + 7 + 7 + 6 + 4 + 3

e = (d) + 1 (screwed)

f = (e) + 8

(The components of each sub-unit are set out in the order in which they are taken.)

Allow the pupils time to search.

Check.

Possible variants.

VI. DRAWING (to be carried out in a later lesson)

Subject: A very simple exercise in construction.

Show pedal No. 3 by means of two illustrations, one of which is a cross-section. Scale 2, format 210 x 270. Show four functional dimensions on the drawing. The following dimensions are given:

- diameter of the spindle: 10 mm
- distance from the axis of the spindle to the point of attachment to the door: 16 mm
- thickness of casing: 4 mm
- dimensions of rectangular opening: 6 x 10 mm^2
- thickness of the pedal: 3 mm.

The missing shapes and dimensions must be "invented".

Instructions

This exercise is one which calls for reflection: it should train the pupil to judge the relative importance of the shapes and dimensions. The important thing in the design of the pedal is that it can be put into position and perform its function.

The pupil will first draw a rough sketch of the external shape and mark the dimensions. The teacher will help him where necessary.

The dimension of the hole will be determined by means of a scale 5 sketch in hard pencil underneath the drawing. On the sketch the pedal will be set at the same angle as in the drawing. At the appropriate time it will be necessary to remind the pupils of some of the practical rules for showing dimensions.

(A teacher's copy of this exercise is given in the Guide Pédagogique pour la Technologie en 4è, Armand Colin Editeurs.)

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COMMITTEE FOR GENERAL AND TECHNICAL EDUCATION

THE TEACHING OF TECHNOLOGY IN ITALY

by

A. TROTTA

THE TEACHING OF TECHNOLOGY IN ITALY

The plan laid down by the Council of Europe for the publication of a series of articles on the teaching of technology provides in its first chapter heading for an analysis of national school systems and a definition of the place occupied by the teaching of technology within the framework of these systems. The second chapter heading provides for a definition of what is meant by the teaching of technology at school level. To my mind these two headings are in the wrong order. The first step should be to agree on the nature and objectives of technological education so that it can then be determined whether such education has been given a special place in the Italian school framework and if so to what extent.

1. The teaching of technology: its nature and objectives and its relationship with the general objectives of education

It is necessary to be clear about the true meaning of the word "technology", as the term is used vaguely and in a rough and ready way. As Mr. G. Gozzer puts it "the expressions technical, technology, technological education are often used in an extremely ambiguous, various and sometimes contradictory manner. They are even used as simple alternatives with an identical meaning" (1).

In Mr. W. Brugger's Philosophical Dictionary we read that in the ancient world and during the middle ages the word technique was used in connection with any kind of craftsmanship designed to meet a need or to put an idea into practice. Technique was the capacity to construct something necessary or to produce something beautiful, by giving visible form to an idea. Thus technique stands for the formal aspect of these operations, the rules that can be transmitted: for example the technique of playing the piano. In contrast to art, technique is the planned use of assets and natural forces for the benefit of humanity (2).

Modern techniques have led to the use of machines which means that the use of assets and natural forces to meet human needs is planned in the light of our knowledge of nature itself.

Introducing the results of the work undertaken by the Commission on the Year 2000, the research group set up by the American Academy of Arts and Sciences, Mr Daniel Bell stresses that much of our present-day interest in the future is due to the bewitchment of technology and the way in which it has transformed the world. Mr. Bell uses the two words "technique" and "technology" to emphasise his belief that

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the first source of change (in society) is "technology". The day will come, he declares, when, thanks to the great changes growing out of biomedical engineering, we shall witness a substantial increase in human longevity. In this connection one should "note that technology itself is changing,... it is not simply a machine but a systematic,disciplined approach to objectives, using a calculus of precision and measurement and a concept of systems that are quite at variance with traditional and customary intuitive aesthetic and religious, modes". Instead of a machine technology, Mr. Bell adds, we will have, increasingly, an "intellectual technology in which such techniques as simulation, model construction, linear programming and operations research will be hitched to the computers and will become the new tools of decision-making" (3).

If technology is regarded as one of the main sources of change in our society it is obvious that the word cannot be applied to the processes, still less to the techniques, by which technology attains its object. Mr. Donald Schon explicitly states in this connection that "technology .... is the set of tools and techniques - 'hard', as in the case of new machine tools, or 'soft', as in the case of new computer programmes considered - by which we extend human capability". Mr. Schon explains in this connection that the process of technological change can be divided into three stages: invention, or the creation of a new product or process; innovation, the introduction of that product or process into use; and diffusion or the spread of the product or process beyond first use (4).

Mr. W. F. Ogburn also refers to this basic cause of social change, but he relates it to techniques not technology. This theory first put forward by Mr. Ogburn himself assumes that socio-cultural changes are dictated by technical know-how. For many people this means that technics, which enable mankind to make practical use of natural laws, represent an independent variable in the changes that take place at a given moment in the structure of society. The continuing alteration of this factor in the form of technical progress determines the tensions and adaptations that occur in different sectors of society.

Just as the word "technique" is generally used to refer to the practical ability, based on knowledge and experience, to attain a predetermined goal, so the word "technology" is used to refer to the study of the technical processes of machines and in general to the study of all processes contributing to the transformation of matter.

After this rather summary attempt to clarify the meaning of the words "technique", "technics" and "technology", it is natural to ask whether it should be left to schools to organise and encourage technological education. That raises some real problems!

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First of all, what are the general objectives of education? On this point Mr. Bertin declares that "in a society that is moving towards technological progress adult education cannot be confined to a mere catching up operation, or to a simple job of qualification, retraining or vocational further training. The aim should be an education preparing for a social life which takes into account all the problems peculiar to a period of transition - problems that express themselves in certain forms of work and of civic and family life and hence appear in yet other forms: changes in patterns of life and behaviour; contrasts between old and new safeguards and opportunities in the occupational field; the antagonisms between the generations that accompany retrograde or progressive trends in moral outlook (5).

It is only when we accept the terms of this definition exactly that we can see the recommendation of the 30th International Conference of the International Bureau of Education (IBE) at Geneva in its correct perspective: the Conference advised that manual instruction should be included in lower secondary education as a compulsory subject and retained, at least as an option, in the upper school. Manual work represents a precious element in the moral, social and aesthetic training of a child or adolescent. Manual work not only makes it possible to discover children's real possibilities but also helps to bring out their aptitudes and to encourage their particular bent. At the same time it is easy to see why at school level neither manual work as such nor technics can lead to the acquisition of the same intellectual equipment as that provided by the study of languages, mathematics and so on (6).

At the first National Congress on technological education Mr. Tamborlini justly stressed that technological education is one of the essential aspects of basic and general culture and of permanent education. "Without technological education", said Mr. Tamborlini, "the future teachers, lawyers and writers will have considerable difficulty in picturing to themselves the modern world that awaits them and which will force them to cling to the experience of the past" (7).

In short, if, on a short-term basis, the general purposes of education include familiarisation with understanding of and adjustment to institutions, and at the same time learning how to change these institutions, it is evident that technological education as a whole must form part of a more general process of education. At the level of the initial phases of acculturation, it will take the form of an introduction to technology that expands steadily in range in proportion as understanding of the great problems of social change takes shape.

2. The place of technological education in the Italian school system

Sweeping educational changes have recently been introduced into Italy by means of the following legal provisions:

(a) Act No. 1859 of 1962, in compliance with the provisions of the Constitutional Charter, instituted a single stage with a uniform curriculum at the lower secondary grade while at the same time raising the school-leaving age to 14.

(b) Act No. 910 of 1968 authorised unrestricted admission to higher education of all holders of any kind of certificate of upper secondary education.

(c) Several measures have been initiated by the government with a view to transforming all the branches of upper secondary education (grammar schools, technical institutes, vocational institutes, etc.). The object of these measures is to co-ordinate all these branches either with the compulsory schooling stage or with the new egalitarian roads to higher education.

At present compulsory schooling consists of 8 years divided into three stages. The first stage (6-8 years) and the second stage (8 to 11) form part of primary education, at the end of which a certificate gives admission to the third stage of compulsory schooling which corresponds to the lower grade of secondary education. This stage lasts for three years, at the end of which a certificate qualifies for admission to any branch of upper secondary education. Under the 1962 reform, subjects studied during the compulsory stage of secondary education are the following: divinity, Italian, history and civics, geography, a foreign language, mathematics and scientific observation, music, art, technical application, physical education and Latin.

Music is only compulsory in the first form, technical application in the first and second forms. Latin, which is compulsory in the second form as a complement to Italian, is again treated as optional in the third form, except for pupils going on to the classical side.

The main object of this stage of schooling is "to assist in the training of men and citizens and to encourage the guidance of young people in order to help them the better to choose their future activities".

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As mentioned earlier, after obtaining his compulsory schooling certificate a pupil can opt for whichever he pleases of the numerous branches of the second stage, that is to say: *the classical grammar school* embracing 5 years (4 forms and the school-leaving form) in which the following subjects are studied: Italian language and literature, Latin language and literature, Greek language and literature, a modern language and literature, history and civics, geography, philosophy, mathematics, physics, natural science and chemistry, history of art, divinity, physical training. *The scientific grammar school* covering 5 years (4 forms and the school-leaving form) in which the following subjects are studied: Italian language and literature, Latin language and literature, history and civics, a modern language and literature, philosophy, mathematics, physics, natural science and chemistry, geography, drawing, divinity, physical training.
The primary teacher training school covering 4 years (3 forms and the school-leaving form) in which the following subjects are studied: Italian language and literature, Latin language and literature, a modern language and literature, history and civics, geography, education and philosophy, psychology, mathematics, physics, natural science and chemistry, drawing and history of art, choral singing, divinity, physical training and, if desired, a musical instrument (8).
The school for kindergarten teachers covering 3 years (two forms and school-leaving form) in which the following subjects are studied: Italian language and literature, history and civics, geography, mathematics, natural science, book-keeping, education, hygiene and child welfare, music and choral singing, domestic arts, divinity, physical training, practical teaching and drawing.
The arts grammar school covering 4 years (three forms and school-leaving form) in which the following subjects are studied: Italian, history and civics, mathematics and physics, natural science and chemistry, history of art, perspective, drawing, anatomy, portraiture, architecture, divinity, physical training.
The technical institute covering 5 years (four forms and school-leaving form) and consisting of several types: commercial, institutes for girls, touristic, agricultural, nautical (for activities connected with the sea), industrial, institutes for surveyors (that is to say for building and public works).

The institutes, all of which provide vocational training, generally offer a wide variety of special subjects within the same branch. It is enough to mention here that industrial technical institutes alone teach 32 different special subjects.

Subjects common to all branches are the following: Italian language and literature, a modern language and literature, history and civics, geography, mathematics, physics, natural science and chemistry, elementary law, divinity and physical training. It goes without saying that the other disciplines depend entirely on the type of technical institute concerned.

Vocational institutes covering from 2 to 5 years according to speciality, provide training for seafaring activities, agriculture and the hotel industry. Subjects common to all branches are the following: Italian, history and civics, geography, mathematics, natural science, a modern language, divinity and physical training (9).

3. Brief analysis of curricula, degree of liberty allowed in preparing syllabuses, etc.

We will now turn to consider what stage the teaching of technology has reached in the Italian school system among the various branches of upper secondary education. Having decided what is meant by technological education and bearing in mind what we have just said under heading 2, can any of the instruction provided under these curricula be regarded as technological? The same question applies to the lower, compulsory stage of secondary schooling.

In technical institutes specialising in "industrial electronics", for example, subjects studied include general electrotechnics, electric measures, general electronics, industrial electronics, technical draughtsmanship, general technology, mechanics, etc. Although centred on vocational training, subjects such as general technology, the technology of electronic engineering, the technology of paper manufacture and many others play a considerable part in a really efficient technological education.

The same is true of the vocational institutes, in which the theory and practice of draughtsmanship play a very definite part. As has been said recently, "knowledge of draughtsmanship and its correct use are no less important as instruments of communication than writing or the correct use of language".

In this type of institute it is definitely general technology which is of fundamental importance, even though it is only taught in the top form. The syllabuses provide that the teaching of this subject should aim at giving pupils an adequate knowledge of the materials used in electronic engineering, of finishing processes, of the rudiments of rational methods of work and supervision and, finally, of testing systems.

In 1967, under the auspices of the European Centre for Education of Villa Falconieri, the first National Congress on technological education was held at Frascati. After having noted that "the problem of technological education (regarded as the study of the impact of innovations and technological progress on the educational system and teaching problems) will probably be the main topic of conversation for the next twenty years", the participants broached the question of the teaching of technical applications during the compulsory stage of secondary education - a marvellous opportunity to pass on at last to discuss the question of technological education in greater depth.

Basically the essential problem of technical subjects lies in the fact that they are still treated as partly optional. Act No. 1859 of 1962 provided that this type of education was only compulsory in the first form and it was not until 1966 that it was made compulsory (for two hours weekly) in the second form. As a result of experiments carried out a short time previously in "observation classes" in which this sort of activity (formerly carried on in the old "Scuole di Avviamento al lavoro" or short course vocational training colleges) was used for training purposes, it was eventually agreed to set aside a definite place for this discipline during the last stage of compulsory schooling.

In this connection many people still think that those responsible for drawing up the ministerial syllabuses for instruction in technical subjects made little attempt to put their finger on the bases of technical knowledge but tried instead to resurrect problems connected with practical education that are altogether too vague. This view is certainly confirmed by perusing the syllabuses for technical applications that were approved by the Regulation of 21 April 1963.

In the first form the pupil is only expected to turn out rationally conceived objects or contrivances of a simple nature and to pursue various other activities in fields chosen by himself in which it is for him to visualise the results he will eventually achieve, after passing through all the necessary phases, in the light of his own knowledge and his teacher's explanations. In the second form (and in the third form if the pupil has chosen accordingly) experiments based on his previous activities are to be continued, but in greater depth, and technological observation and diagrams are to be encouraged.

In this connection it is very interesting to examine the explanations that accompany the syllabuses issued by the Ministry. "By making use of the knowledge a child has acquired and the observations and experiments he has made through studying facts and natural phenomena, instruction in technical application is intended to satisfy his active interests and develop his ability to identify and define shapes and the relationship between dimensions by means of drawings and diagrams. It also aims at preventing the pupil from falling into the habit of ignoring the functional and aesthetic requirements that are always implicit in any artistic or expressive undertaking, and at giving him some elementary knowledge of materials and tools, their characteristics, qualities and functions. Technical application cannot fail to contribute to the harmonious development of the child's personality, enabling him to fulfil himself in a reasoned activity at all sorts of levels that bring into operation a conscious mental process. The child will in this way be prevailed upon to tackle subjects that are feasible through the preliminary study of the difficulties that have to be overcome in relation to the abilities of each child and the means available."

It goes without saying that these aims not only require a special methodology of their own but also the establishment of a give-and-take between master and pupil; thus the master, whilst accepting the pupil's initial choice, will continue to stimulate his critical faculties and without ever interfering with the child's spontaneity, will press him to become more mature. "The pupil", the ministerial syllabus goes on to say, "will be encouraged to organise himself and his work in a rational way, so as to achieve the required results via the various operative phases, namely: ideation, planning (sketch and diagram, drawing, choice of materials and implements, costing), execution, critical discussion and, last of all, conclusive demonstration".

It is by means of this kind of methodology that a pupil learns to think through a process of trial and error and to become aware of the underlying theoretical and scientific principles upon which all true experimental work rests. This is how he gradually acquires the capacity to combine in a rational way the theoretical and practical elements in the creative process.

As for school syllabuses, ministerial instructions are not over-strict where technical applications are concerned. They merely advise boys, as being more suited to their character and interests, to transform certain raw materials (e.g. wood, metal, plastics) into finished products, or to assemble some modest contraption out of materials to hand.

Girls on the other hand are channelled into domestic occupations, whilst furnishing, interior decoration, gardening and horticulture are regarded as equally suitable for both sexes.

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After insisting on the necessity for the children's co-operation, the ministerial report concludes by stressing the fundamental importance of technical applications that enable children to grasp more and more fully the spiritual significance of man's work and its social aspects in the world of today.

Clearly, all the above are simply general suggestions. As far as putting into practice or organising a particular syllabus is concerned, the greatest latitude is left to pupils and teachers.

4. Premises and materials available for education in technology

Since there are never more than 25 pupils in a class it is easy enough to get them working to good purpose, making use of such equipment of the former "Scuole professionali di Avviamento al lavoro" as is still serviceable. This does not prevent the authorities from improving facilities by providing new standard multi-purpose equipment which can be added to each year.

Unfortunately premises are very often far from comfortable; however, the school building programme includes a plan for installing new, thoroughly functional workshops and laboratories.

5. Some characteristic examples of activities connected with technology

Since most of the teaching staff have welcomed team-work, all work is organised in groups from the preliminary outline to the final demonstration. The main characteristic of this type of teaching is however the almost continual search for a motivation modelled on the children's surroundings. Thus in the country forms will devote themselves to technical applications of an agricultural nature, while in the towns and large industrial concentrations the children will be guided towards practical work connected with engineering, electronics or electrotechnics.

6. Training and refresher courses for teachers of technology

Here an initial distinction must be made between teachers of technological disciplines that form part of vocational training in technical institutes and teachers of technical application in the final stage of compulsory schooling. Whereas the former have all received higher education - mostly at faculties of engineering or polytechnic institutes - the others have attended practical courses leading to upper secondary school certificates. Even so we can say that generally speaking both categories of teacher are capable of giving instruction in their subjects.

However, as technology and technics are liable to change extremely rapidly, these teachers scarcely ever manage without refresher courses. Accordingly, the National Education Centre for lower secondary schooling organises courses in each Province for teachers of technical subjects, while the National Centre for technical and vocational instruction organises national courses at a much higher level to keep teachers of technics and technologies at upper secondary institutes abreast of their subjects.

7. The influence of technological education, etc.

Technological education has a very constructive effect, as we have seen, on the guidance of pupils in connection with their studies during their compulsory schooling; but it has an equally marked influence later. We need only mention the part played by technology in industrial technical institutes. There it is not only focused on vocational training, in which it plays a major part. It also awakens pupils to new interests and, we may even venture to say, orientates them towards a certain form of permanent education.

In the compulsory stage of secondary education, it gives a pleasant dash of colour to the various types of instruction, especially when it intermingles with such disciplines as art history or elementary science. This leads to a better attitude among the pupils towards the understanding of new techniques and means of expression.

We have already seen that technical application has become increasingly popular with pupils to the detriment of other optional subjects such as Latin or music. This has led the authorities to make this subject compulsory in the second form also with a probable view to its introduction into the first two forms of upper secondary school.

In our opinion technological education cannot fail to develop an interdisciplinary role and function: a subject that will be strictly bound up with other activities, encouraging in all its forms the guidance of pupils throughout the first two years of upper secondary education.

ANTONIO TROTTA

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GENERAL STRUCTURE OF EDUCATION IN ITALY

The reform of 1962 made attendance at school compulsory up to the age of 14 and this has been the rule ever since.

The reform of 1969 allowed unrestricted admission to all types of higher education to everyone holding any kind of school-leaving certificate.

Successful completion of all upper secondary studies is attested by a school-leaving certificate.

The educational system includes four main levels, excluding pre-school education provided at nursery schools.

Primary education

5 years	- from 6 to 11 - first cycle (1st and 2nd years) - second cycle (3rd, 4th and 5th years)

Secondary education: First stage

3 years	- from 11 to 14 - forms: 1st, 2nd and 3rd - uniform curriculum

Secondary education: Second stage

5 years	- from 14 to 19 - forms: 1st, 2nd, 3rd, 4th, top - types of establishment: grammar schools, technical institutes, certain vocational training institutes - curricula: classical, scientific, technical, vocational
4 years	- from 14 to 18 - forms: 1st, 2nd, 3rd, top - types of establishment: art secondary school, primary teacher training school, certain vocational training institutes - curricula: education, art, vocational subjects.

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3 years	- from 14 to 17 - forms: 1st, 2nd, top - types of establishment: school for kindergarten teachers, certain vocational training institutes - curricula: education, vocational subjects

N.B. In several towns there are schools of music whose organisation depends on the specialisation followed.

Higher education

University faculties - 4-6 years. A single type of degree.

Academies of fine arts

Military academies

Academies of music

Polytechnic institutes

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(6) Recommendations of the 30th International Conference of the International Bureau of Education (IBE), Geneva, 1950.

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(8) In December 1970 the Government tabled a Bill to extend these courses to 5 years.

(9) As the Committee for General and Technical Education is primarily concerned with the teaching of technology at secondary school level, higher education is not dealt with here.

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Strasbourg, 31 August 1971

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COMMITTEE FOR GENERAL AND TECHNICAL EDUCATION

THE TEACHING OF TECHNOLOGY IN THE UNITED KINGDOM

by

A.A. HAIMES

1. Description of the system (see also diagrams: page 3 and 4).

In the United Kingdom the system of education is decentralised. Local education authorities are required to provide facilities for the education of their young people according to age, aptitude and ability. Although this broad commitment applies to the whole United Kingdom, member countries have educational systems which differ in detail. That of Scotland is briefly described in Section 7(a) of this article and of Northern Ireland in Section 7(b).

In England and Wales, under the Education Act of 1944, secondary schools were established for all pupils over 11 years of age. Progress with this reorganisation was to a large extent controlled by economic factors and by the need to build more primary schools because of the post-war increase in the birth rate. A few authorities decided to provide secondary education in comprehensive schools, but the majority preferred smaller schools with a more limited range of ability. They retained schools of an academic type, now called grammar schools, for about a fifth (1) of the age group, selected by examination, and established others known as modern schools for the remainder. The secondary technical school, which was intended to provide an education alternative to that of the grammar school, proved to be less popular, and schools of this type were built in only a few areas. In recent years there has been a growing movement away from selection of pupils for these different kinds of secondary school, and comprehensive schools now accommodate about 30% of secondary pupils in the State sector. Independent schools recruit at any age, but the larger independent schools, known as "public schools", usually recruit at 13+ on the results of the Common Entrance Examination.

The aim of all secondary schools is to provide a sound general education; vocational education is regarded primarily as the concern of further education establishments, which, in co-operation with industrial training organisations, provide full-time and part-time education and training more closely geared to the needs of industry and commerce. Technical subjects, including practical work, are, however, regarded as an essential part of general education, and most secondary schools have workshops and home economics rooms. Naturally, pupils who are studying two or three languages or two or more science subjects may have less time allowed for such activities, but others, of whom some are among the ablest, may have a programme which allows them perhaps half a day a week over a period of five years or more for technical subjects. The choice of curriculum is the concern of the headmaster, in consultation with the pupil and parent.

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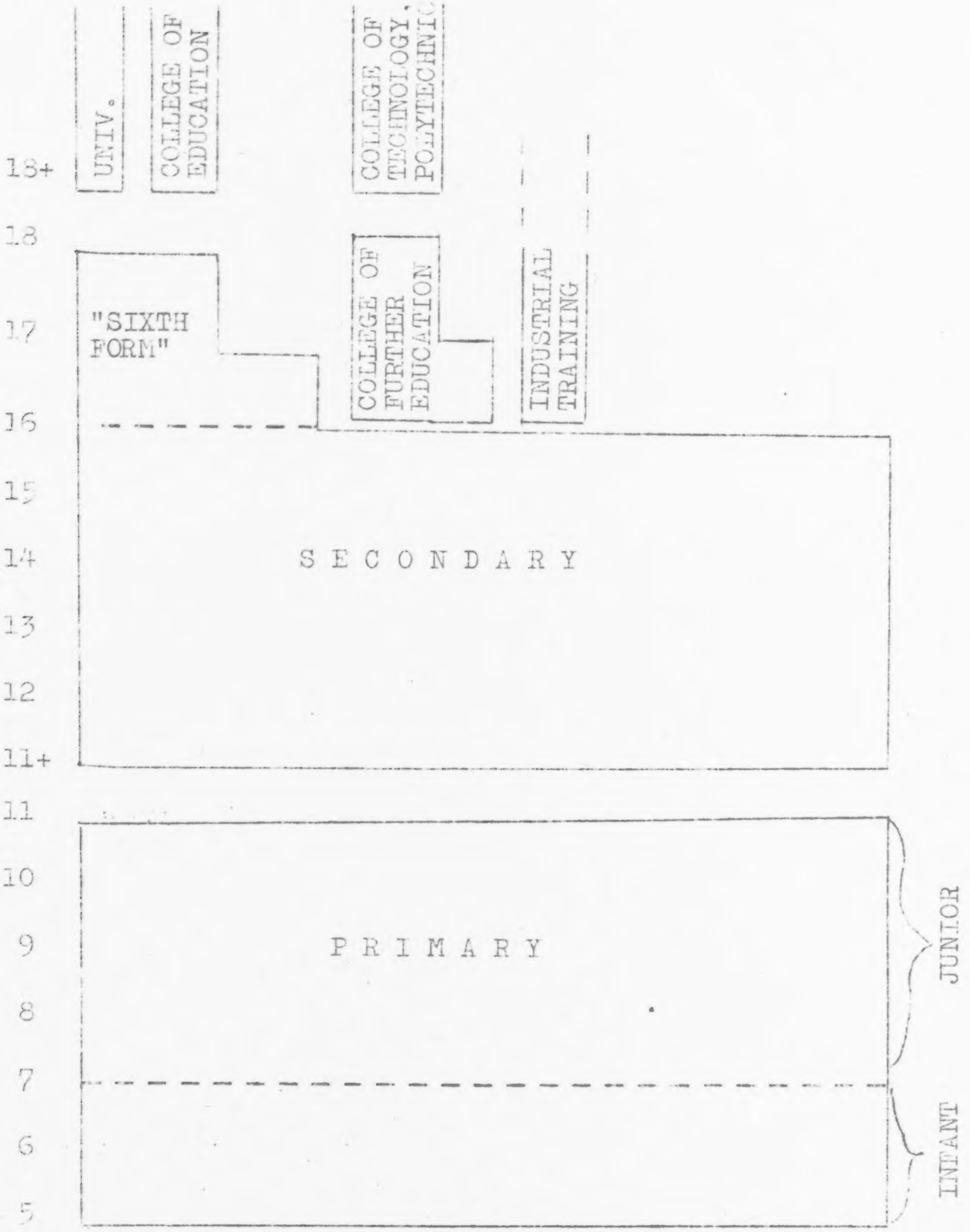
(1) This proportion varies widely in different parts of England and Wales. In some areas it is only a little above 10%, while in others, for example in parts of Wales, it rises to 40% or more.

Although secondary technical schools have been less numerous in England and Wales than other forms of secondary school, they have had considerable influence and have played a leading part in the development of courses with a technological bias. During the past ten years or so, such schools, and others from the maintained and independent sectors, have been experimenting in this field and eventually a clear case was made out for a more systematic development of this kind of work. At this stage the engineering institutions, the Association for Technical Education in Schools, and many others, including groups of inspectors, advisers and teachers, were working to the same end. During 1966/67 the Schools Council set up a project to assist in this work. The Schools Council is an organisation concerned with the curriculum and examinations; it is supported by public funds but is largely under the control of the teaching profession. One of its first actions was to publish Curriculum Bulletin No. 2 (see bibliography page 23) and to set up a research and development group known as "Project Technology", which is now producing material for use in schools at the discretion of the teachers. It is not anticipated, however, that such material will be used universally or that it will be limited to a specific age group. Technology is not usually regarded as a subject, but rather as an activity affecting several subjects. Although most of the schools concerned regard 13 to 16 or 18 as the most suitable age range, there are others where younger children may be involved.



ORGANISATION DIAGRAM FOR MAINTAINED SCHOOLS IN ENGLAND AND WALES

Notes:

i. In most areas pupils are promoted from primary to secondary school at the age of 11

ii. The leaving age, at present 15, is being raised to 16 in 1972/73

iii. Pupils leaving school at 16 may continue their education full-time or part-time as shown above

iv. Some students in colleges of education are recruited from colleges of further education and many sixth form pupils gain admission to colleges of technology and polytechnics

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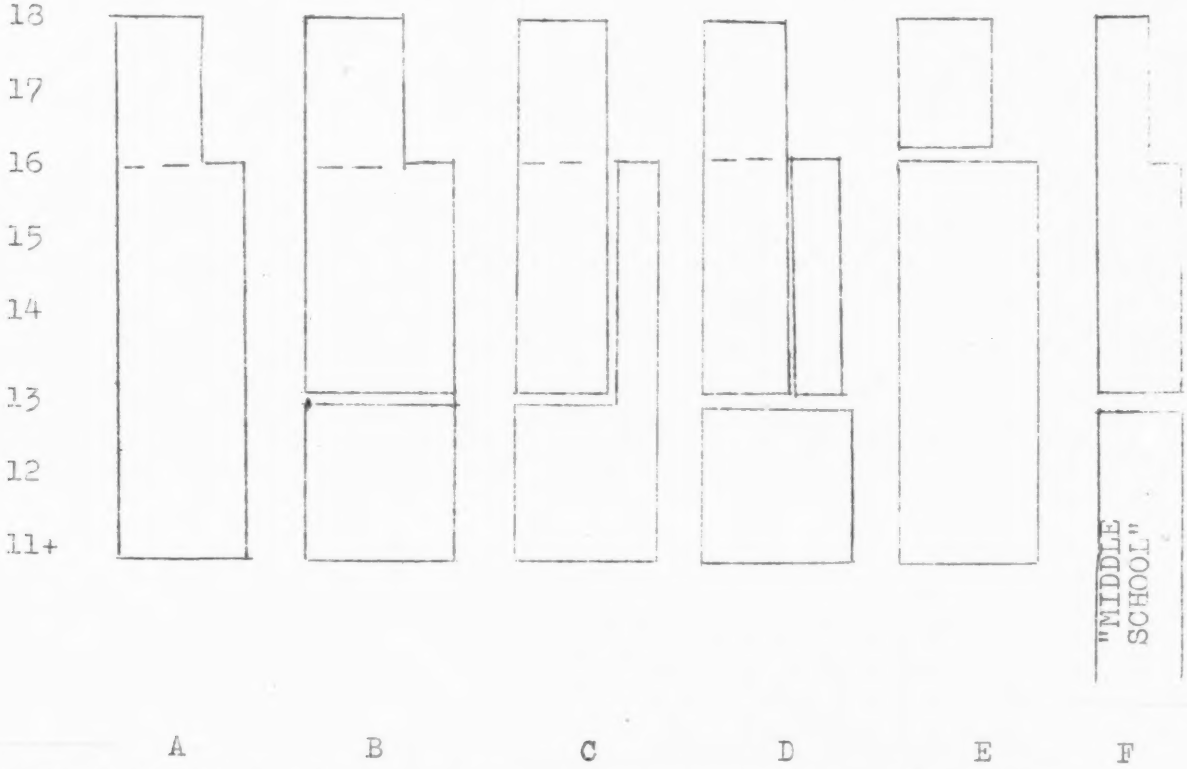

PATTERNS FOR THE COMPREHENSIVE REORGANISATION OF MAINTAINED SCHOOLS IN ENGLAND AND WALES

Such comprehensive development as has taken place in England and Wales has been on one or other of the following patterns, depending on local opinion and on the nature of existing buildings.

A. is the orthodox "all-through" comprhensive, requiring a new building or the conversion of two or more existing schools to form one unit

B. involves transfer at 13 from a junior comprehensive to a senior school

C. allows a choice of school. Pupils may remain where they ar after the age of 13, and leave school at 16, or they may transfer to another school where they will remain until 18

D. is similar, except that at 13 all pupils transfer to one of two senior schools, one offering courses to 18 the other to 16

E. involves the creation of a "sixth form college" for those ov the age of 16. Sometimes this provides for academic courses only, the rest being provided in colleges of further education. Some authorities, however, are combining all the full-time education for the 16 to 18 age group in one establishment

F. is an alternative pattern which is being followed by about a quarter of the Local Education Authorities to introduce "middle schools", usually for 9 to 13 year old pupils. They thus enter secondary school at about 13 years of age

2. What is meant by technology?

A popular dictionary definition of technology is "the science of the industrial arts", Since the war, the word has come into more common use and now has a much wider meaning. In a recent government report it was defined thus:

> In every technology the ultimate purpose is to exploit existing scientific and other knowledge for productive ends .....
>
> 1965 Triennial man-power survey
> CMD 3103

This statement goes on to emphasise that technology is a creative activity working in the interests of society, and it is this aspect which has caught the imagination of many pupils and teachers in recent years. By using the methods of the scientist, the expertise of the craftsman and the knowledge of the historian or the geographer, schools have been able to identify problems and find solutions to them. Sometimes the product may be an actual object, such as a hovercraft, but it might also be a technical report or a humanitarian study which led to some attempt to meet the needs of old or handicapped people. In schools, therefore, technology is a term used to describe an activity associated with one or more of the traditional subjects, and only rarely is it at present regarded as a subject in its own right. Schools and teachers are free to introduce it if and where it seems opportune to do so, and they may pursue it as far as seems profitable. Consequently, it may be a minor activity in some situations, whilst other schools may devote much more time and enthusiasm to it.

"Technology" is also a term used in further education to describe the institutions concerned. It has no special significance nowadays in showing the level of work for which they provide. Thus some are known as "colleges of technology", whilst similar institutions elsewhere are called "technical colleges" or even "colleges of further education". In general they provide educational courses at all levels for craftsmen and technicians. The former colleges of advanced technology have now become new universities awarding their own degrees.

For boys and girls in school, technology is increasingly being regarded as of general educational importance. As future citizens they must be familiar with concepts of technology which will have an important influence - for good or ill - upon their lives and environment. They must learn not only to exploit but to control them. By helping pupils to design, make, test, modify and use devices and equipment the teachers seek to stir their imagination and sense of wonder, build up their knowledge, develop their skill and heighten their

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respect for man's efforts. In real situations such as these they can weigh the advantages as well as the disadvantages of techniques and materials, old and new, savour success as well as failure and at the same time have the opportunity to consider the possible harmful effects of what may at first sight seem to be adequate solutions to the problem of providing for man's material needs.

The following may be mentioned as specific aims of technology in schools:

i. to encourage pupils to be inventive, and to produce original and imaginative work;

ii. to help pupils to analyse a new situation and to decide upon the significant factors;

iii. to help them to apply their knowledge of principles and procedures in reaching a possible solution, or solutions;

iv. to give experience in planning and constructing devices so conceived;

v. to train pupils to recognise the limitations of a design and to suggest modifications;

vi. to promote confidence in the use of unfamiliar and possibly complex equipment;

vii. to encourage pupils to keep faithful and methodical records, of failures as well as of successes.

3. Curriculum

Schools have considerable freedom in curriculum matters: neither the subjects that are taught nor their content are controlled by the government, except indirectly in that accommodation and equipment in new schools is provided on a scale which assumes that a pattern will be followed. However, both internal and external influences are such that there is a good deal of agreement about what should be taught. Although schools are free to submit their own syllabuses, examinations continue to exert powerful pressures at certain points, since success in specified subjects may determine entry into professions, to establishments of higher education, or to other avenues for training and education. One of the purposes of the Schools Council (See (1) above) is to keep examinations and the curriculum under continuous review. At the moment the Council is negotiating with universities and other interested bodies possible improvements in the examination system. The system is often crticised because it encourages an early choice of subjects which may result in a narrow education. This in turn could render a pupil ineligible for certain careers later on.

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At present the distribution of periods in the curriculum for the first two or three years of most secondary schools is as follows:

Religious education	2
English	5
History	2
Geography	2
French (or German)	5
Music	2
Mathematics	5
Science	4
Art/craft	2
Handicraft or home economics	2 or 3
Physical education	3

(In grammar schools, where Latin may be introduced at the age of 11 or 12, and in Wales, where 4 periods are allowed for a study of the Welsh language for many pupils, the number of periods for some subjects will be slightly less than indicated.)

These figures are typical for schools operating a 35-period week (periods of 40 or 45 minutes each). Many schools, however, operate a 40-period week but with a similar distribution of time. After the age of 14 some subjects may be "dropped", for example, to enable Latin, Greek or another modern language to be introduced, or to allow six periods for science (including biology). In the sixth form (16-18 years of age) three subjects may occupy more than half the week, with private and general studies to balance the programme. As in many other countries, the existing curriculum pattern is, however, being questioned. Believing that the curriculum is more than a collection of subjects, teachers are debating the purpose of secondary education and redefining its objectives.

In order to ensure the full development of individual pupils, necessary knowledge, skills and attitudes must be imparted, and if the young person is to fit into society he needs some knowledge of his environment and of the society in which he lives. The school, too, seeks to impart certain ideals and aspirations, and, bearing in mind the increasing importance of leisure time, it also attempts to give opportunity for recreative and aesthetic activities. Such thinking leads to discussion of the balance between different elements of the curriculum, and in this context the question of technology is also relevant. Because it overlaps traditional subject boundaries and involves a number of subject disciplines, technology can give greater coherence and relevance to the curriculum as a whole.

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In a recent essay "towards a balanced curriculum" (TRENDS No. 18 HMSO) it was proposed that the curriculum should be thought of in blocks of time or "areas" rather than in terms of individual subjects. Each area would represent an essential element of knowledge or experience and, although pupils might select within it, they might not omit any area entirely. Thus, after two or three years they might elect to continue with art, music or craft, but they could not give up all the practical/aesthetic group of subjects. This interesting proposal gives a variety of curriculum patterns, one of which might be as follows:-

	Lower school (ages 11-13/14)	Years 4 and 5 (ages 14-16)
Languages and literature	8	8
Maths/sciences	9	9
Modern studies (including history and geography)	6	6
Aesthetic/practical and physical education	9	9
Uncommitted (to be used to meet pupils' needs)	3	8
TOTALS	35	40

(It will be noted that the proposal assumes a longer working day for older pupils.)

Within such a pattern technology could find a place in several areas or blocks of work and the "uncommitted" time could be used to augment the programme as necessary.

As with the curriculum, matters of organisation, time-table and teaching method are decided at school level, but to some extent they are controlled by limitations of staff or accommodation. Classes in most secondary schools are around 30, but workshop classes are usually limited to 20 for safety reasons. In the upper school, especially at sixth form level (that is 16-plus) teaching groups are usually smaller than this and pupils are allowed time for "private study" also.

There is no standard method for teaching technology and teachers enjoy a large measure of freedom in deciding upon their approach to the pupil-centred activities followed in the work-shops and elsewhere in the school. It is, however, usual for schools to treat technology as a group or individual activity related to existing subjects. Sometimes it may be closely associated with science, at other times with craft and often with other subjects, including history, mathematics and art. Teachers and pupils are thus engaged as a team. For a major undertaking, different teams may tackle different aspects of the same project.

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"Project technology", mentioned above, has assisted teachers by means of conferences and publications, and by providing practical help in their early experiments. Once they have made a start, teachers are encouraged to assess their progress and to seek ways of maintaining it; the various publications now being prepared are all intended to assist this process.

4. Premises and equipment

Most secondary schools are provided with:

- laboratories for physics, chemistry, biology and/or general science and facilities for rural studies;
- workshops for woodwork, metalwork (including some machine work) and sometimes for building;
- drawing offices, usually linked to the workshops;
- rooms for home economics.

Larger secondary schools, having more workshops and more laboratories, offer scope for grouping the rooms according to subject interests. They can also afford to equip certain rooms more generously and for more highly specialised purposes. For example, they may have a laboratory for engineering science or electronics. Often there is an additional "working space" for:

- large-scale project work (boat building, go-carts, trailers, hovercraft etc.);
- informal work during private study periods or as an out-of-school activity.

Some schools have adapted existing accommodation or built for themselves an extension or separate building, sometimes in substantial brick construction, in which to pursue such activities: this has given them an insight into building technology as well as practical experience in building techniques. Where the teachers are prepared to use the educational opportunities to the full, the pupils are encouraged to take part in the planning of the work, in the preparation of sketch plans and detailed drawings, in seeking planning approval from local authorities, in drawing up bills of quantities and estimates and in ordering materials. In addition to the usual laboratory and workshop equipment, schools are purchasing or making for themselves other items such as:

- cathode ray oscilloscopes, stroboscopes and other electronic devices;
- simple test rigs, for example, for engine testing, structures and materials testing, hydraulics and aerodynamics.

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At school level not much use is made of published audio-visual material because the emphasis is on activity rather than upon acquiring information. But some good material of this kind is now available, for example, in connection with the several Nuffield science projects. For use in further education and in industrial training, a great variety of aids are now produced, including film loops and programmed learning books. Some of this material may well be useful in schools, as, for example, that dealing with simple electronics or logic circuits. Excellent films and teaching material are available about engineering, metals and materials, oils and lubrication from the major oil and metal-producing companies and from the government-sponsored Central Office of Information. Some schools and colleges of education are experimenting with programmed learning material of their own making, for use in the teaching of basic scientific principles and of technical drawing. It is likely that more material of this kind will be produced to help teachers and pupils to learn the theory they need in order to make further advances in their project work. Some knowledge of principles is of course essential at the outset, but the need for further knowledge and skill arises as the work proceeds. The excitement aroused by the project itself provides the motivation.

5. Typical examples

In the absence of any central control over the curriculum it is not possible to give a precise estimate of the number of schools claiming to teach technology, but it is known that about a thousand are already in touch with project technology and have expressed interest in becoming actively involved. It is, moreover, impossible to select schools typical of the country as a whole. Those mentioned below and in the Appendix represent some of the pioneers, mainly in the field of engineering where most of the development has so far taken place. They include different age and ability groups and their work illustrates the wide variety of experimental teaching that is developing. The five schools mentioned in greater detail include an independent boarding school, a comprehensive school, and three other secondary schools - grammar, technical and modern.

HAYLE COUNTY SECONDARY SCHOOL, CORNWALL, is situated in a small seaside town in the extreme south-west corner of England. It is a mixed secondary modern school drawing its pupils from an area also served by a grammar school which the majority of more able pupils attend. The neighbourhood is predominantly rural but the holiday industry and the small towns provide much of the employment. Hayle itself is of interest because of its connection with the mining industry, and relics of the tin mines and of their great pumping engines abound in the district.

These industrial monuments have been a source of inspiration to staff and pupils, and both boys and girls have studied them in a number of surveys of their environment. Their interest in past technology has led to similar studies of what man is achieving today; local examples of this include the china-clay industry, the manufacture of pumps and compressed air equipment and a number of enterprises connected with the sea. Pupils from the school have won several prizes for things they have designed and made in the workshops, where there are facilities for practical electronics as well as for woodwork and metalwork. The school workshop exploits technology as fully as possible and by the use of projects and themes is able to give practical backing to most subjects. The school's environmental studies have been filmed by the BBC and used in its television broadcasts for teachers.

DANUM GRAMMAR SCHOOL, DONCASTER, was built as a selective secondary technical school. For many years it has been one of the pioneer schools in technology teaching: project work for sixth-form pupils, new examinations embodying investigations by candidates, and integrated courses involving craft, science, drawing and other subjects, have all been introduced with considerable success. Recently, with the help of funds provided by project technology and the Local Education Authority, the school has co-operated with non-selective schools in the Doncaster area in devising a common scheme for pupils of mixed ability in the age range 13 to 16. Using readily available commercial components for constructional work, pupils are introduced to electrical, mechanical, electronic and pneumatic methods of control. They proceed by a series of investigations and simple design exercises, acquiring essential new knowledge as they go. Although the scheme is still experimental, it is already clear that pupils can make and assess the performance of small machines and other devices designed to carry out specific tasks. For example, by the end of the first year's work they are able to devise and make a machine capable of sorting nuts and bolts in batches of ten. It will be interesting to see how far pupils can go in the three years, and what effect this important addition to their skill and knowledge may have upon project work in the sixth form.

GATEWAY SCHOOL, LEICESTER, is another secondary school well-known for its technological work. The school is adjacent to a polytechnic in the centre of the city, where close links with the college and with industry can be maintained. Recently a new addition to the school has provided excellent practical facilities and this new building is the focal point for design work. For a very long time the school has set high standards of design and craftsmanship as one of its primary objectives and it offers opportunities for pupils to experience a very wide range of crafts from stone carving to practical electronics. The school has in the past attracted pupils of very high intelligence, and has a fine academic record - but all pupils participate in the practical work. The sequence of work leading up to the construction of the device described in the Appendix is of special interest because it illustrates how, from small beginnings, a theme may develop over a period of years and still not be exhausted, although the direction of the work has often changed and different masters and pupils have been involved. Other themes, are, of course, running concurrently and the effect is to maintain a creative, experimental atmosphere throughout the school.

WOODBERRY DOWN SCHOOL, LONDON is a relatively new establishment built as a comprehensive school for boys and girls during the post-war period, offering academic or technical courses for the upper ability ranges and a variety of opportunities for others. It was one of the first schools of this type to be associated with project technology and it has been possible to experiment over a wider ability range than in the case of the other schools mentioned. But in fact the most regular use of technological themes occurs in the 14 to 16 age group among boys who are taking practical subjects as a part of their course for examination purposes. In the workshops, pupils are encouraged to play an increasing part in the design of what they make, and some of them concentrate their efforts upon items of technological interest rather than upon the making of tools or furniture. At sixth form stage (i.e. 16 to 18) the work is rather more wide-ranging, some of it involving pupils whose interests are in the social aspects as well as those following scientific or technical programmes.

TONBRIDGE SCHOOL, KENT, is an independent boarding school for about 550 able boys in the age range 13 to 18. Like many schools of its type it has a high academic record and nearly all pupils take three subjects at advanced level; about sixty per cent of them proceed to university on leaving school. Technical subjects do not occupy a large part of the curriculum, but all boys attend the workshops during their first two years at the school, and they are then encouraged to spend some of their optional periods or spare time - which is of course not inconsiderable in a boarding school - on a practical or aesthetic pursuit. Technology has been introduced into the programme because of the opportunity it affords for creative, disciplined work. Projects may be investigational or constructional and it is possible for boys to spend as much as eight hours a week upon them at certain stages; they would not, of course, do this regularly. Pupils are encouraged to plan and organise their work, with due regard for scientific principles, the economics of their task, and sources of information and assistance that they may need. In this connection the school has good links with many higher education, research and industrial organisations.

Descriptions of some of the work of the above schools, and of the way in which technology is introduced, are given in the Appendix. The following examples of other projects and investigations have been selected from details of an exhibition held at the Imperial College of Science and Technology, London, where the work of some fifty schools was on show.

i. A group of 15-16 year old pupils investigating the beneficial and harmful effects of weed-killers, noticed that some plants in the laboratory were unaffected when others were severely attacked by greenfly. Plants such as the pelargonium seemed to survive, and miscroscopic investigation of their leaves suggested that they might exude a liquid insecticide. Attempts were made to isolate and to use this natural fluid, and other similar plants were to be investigated.

(Park School, Swindon)

ii. Some sixth form pupils wished to experiment with enzymes but felt that they needed a colorimeter to investigate rates of reaction and the factors affecting them. They were able to obtain details for the construction of this piece of equipment and to obtain the results required. The apparatus is now in use for biology teaching at several age levels.

(Danum Grammar School, Doncaster)

iii. A school on the fringe of London experimented with several methods of forming shapes with plastic materials. Casting in resin, pneumatic methods of producing bowls from plastic shoot, injection moulding and centrifugal casting have all been tried out using equipment manufactured in the school's workshops.

(Manor School, Ruislip)

iv. A neighbouring school has produced a vacuum-forming machine for plastic sheet, with the help of the polymer science department of Brunel University. This device has proved valuable in co-operation with subjects such as geography and art.

(Hayes County Grammar School, London Borough of Hillingdon)

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v. Strain gauges, consisting of a fine wire or foil conductor bonded to a thin elastic base, are often used in the study of structures. The gauge is attached to a bridge, aeroplane or machine, which is then investigated under load: the change in electrical resistance indicates the mechanical strain in the member under investigation. One school has constructed an apparatus to illustrate the principle of the strain gauge.

(Cray Valley Technical School, London Borough of Bromley)

vi. The investigation of materials has afforded many opportunities for project work and one school has developed electrical methods for measuring small deflections, which has been applied in the measurement of hardness and in measuring torque in rotating shafts.

(Bexley/Erith Technical High School, London Borough of Bexley)

vii. One school has an applied science club which meets once a week after school. A member of the club decided to construct a device which would operate a sign indicating whether pupils should be allowed in the school during wet or very cold lunch-times. Using a transistorised circuit a simple and very effective solution to the problem was reached.

(Barton Peveril School, Eastleigh)

viii. The linear induction motor has been a popular field for investigation and several schools have constructed models of it. In one example a motor runs at speeds of about 4 metres per second on a track 6 metres long.

(Barton Peveril School, Eastleigh)

ix. The technical activities centre established at this independent school has attracted a great deal of interest and its work has been filmed (see bibliography, Section iii.). After a short period of initiation, pupils may undertake project work including the making and testing of model aeroplanes, boats and devices of all types. A distinctive feature of the work is the way in which pupils are required to follow a programme of self-instruction; giving them the background knowledge they need for their project.

(Sevenoaks School, Kent)

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x. The provision of aids for disabled people presents a problem, since individual needs are so varied. For the pupil at school, however, it is an ideal assignment: he can meet the person concerned, design and make the necessary device, see whether it is working satisfactorily over a period of time and make necessary modifications to it, for example to allow for growth. The "Aid for the disabled" service which one school has established collects information about the needs of disabled persons in the area, and arranges, in co-operation with the medical services, for necessary help to be provided. For example, pupils have made special crutches, standing frames and other training aids. They have also modified standard equipment, for example, children's tricycles, so that they can be ridden by children with weak ankles.

(Wanstead County High School, London Borough of Redbridge)

xi. When a motorway is built through a rural area, vast changes are brought about in the ecology of the countryside and in village life. A group of schools in Wiltshire is making an extended study of these problems during the construction of the M4 motorway and the approach roads and bridges across the country. Engineers have also provided interesting details of these features.

(County of Wiltshire)

xii. Fibres and fabrics has been the subject of an investigation at a girls' high school. They have studied the effects of commercial and laboratory preparations upon woven fibres and human hair, the dyeing of fabrics and the flame-proofing of materials. The shrinkage problems have also been investigated.

(Thoresby High School, Leeds)

xiii. Man's exploration into space has been one of the outstanding achievements of the past decade and one school has been able to keep pace by setting up its own satellite tracking station. Not only has it been able to follow existing satellites but it has detected the launching of new ones and their probable origin. Masters and pupils maintain a continous watch.

(Kettering Grammar School, Northants)

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xiv. It is not difficult to find examples of successful projects carried out by older boys, but work done by younger pupils, and especially by girls, is more rare. In one secondary modern school for girls, however, an applied science course was introduced at first and second-year level (11-13 years of age) in an attempt to break away from more formal teaching. The response justified the extension of this work to the whole school, and the approach is best illustrated by quoting two examples. In order to make a reaction-timer it was necessary to make a binary counter, and for communication purposes an apparatus for transmitting and receiving messages along a beam of light was successfully constructed.

(Player School, Nottingham)

Fuller details of the above will be found in the project technology publication "School science and technology I" (see Bibliography - Section ii.).

6. Training of teachers

Teachers of technical subjects will normally have taken a concurrent three-year initial course of training in colleges of education including science and/or crafts as their main area of study. Others will have a degree or have certain other specialist qualifications and approved industrial experience which hitherto were accepted as conferring qualified teacher status without professional teacher training: of these many will already have taken a course of professional training voluntarily or compulsorily after completing their degree or other specialist qualifications. These courses may be of one-year's duration. Regulations have now been made whereby no qualifications obtained after 1973 will confer qualified teacher status unless the holder has also satisfactorily completed an approved course of professional training. All teacher training institutions, whether in colleges of education or in university departments of education, will be fully aware of the efforts that are being made to introduce creative technology in schools and to prepare future teachers for work in this field. A number of colleges have arranged courses specificially directed to preparing teachers for work in the field of technology; these relate science and mathematics to appropriate craft skills, usually through a series of projects.

Retraining or further training of teachers takes place in a variety of ways, for example:

i. courses of one-year's duration are provided in certain colleges of education. Normally these relate to existing subjects, such as handicraft or science, but there are none aimed at providing specialist teachers of technology as such;

ii. as an experiment one college of technology is offering one-term courses of training with a technological bias. Craft teachers attending these courses may supplement their scientific knowledge and science teachers are able to gain workshop experience: the two groups co-operate in designing and making projects of many kinds during their training;

iii. similar provision is made on a part-time basis in at least one university, where teachers of science and craft may attend a series of lectures and demonstrations over a two-year period;

iv. in addition, short periods of training are arranged by various educational bodies. Those which would have some bearing upon technology include:

   - the headquarters' team and regional groups of project technology;
   - local education authorities, using their own advisory staff, colleges and teachers' centres;
   - the Department of Education and Science, which runs a series of national and regional courses staffed mainly by HM Inspectors and lecturers in colleges of education and in universities.

For some purposes these bodies may co-operate in running joint courses. In most cases the periods of training are of short duration (7-14 days) and the courses are usually held during the school vacation periods.

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Undoubtedly teachers have also been helped to understand the general principles behind recent developments as a result of television broadcasts, "Science Fair" exhibitions, films and brochures distributed by private companies, publications of the Department of Education and Science, the Schools Council and by various reports upon manpower and employment prospects issued by other government departments. Science fair exhibitions are usually arranged regionally and schools are invited to submit exhibits for a local exhibition to be seen by parties of school children and students in the area. Selected examples from these exhibitions are then entered for the Young Scientist of the Year competition and the BBC arranges for panels of well known engineers and scientists to interview the pupils concerned. These programmes are of course seen by a very large number of parents, employers and children and they have stimulated interest and earned considerable support for the movement. In all this publicity about project technology, the importance of allowing the pupils, whether as individuals or in groups, to pursue their own interests in a creative and imaginative way, is strongly emphasised, and supports the view that such experience is an essential element in design education.

7. Evaluation

Although it is too early to assess what the final outcome will be, the main development work in technology began some five years ago and it is important that evaluation should not be delayed, since an evaluation team can also feed back information about trial material that may be of vital importance when publications are being prepared.

A separate "evaluation study" of project technology has therefore been set up by the Schools Council at the University of Keele. Its first aim is to assess the effect of the technology project upon schools and children, and to determine whether it is meeting the needs and wishes of the teachers concerned. It is not possible to look at the whole of such a wide field of activity but a number of important aspects are being studied:

i. The Bulletin (issued five times a year to 6,000 or 7,000 readers). A readership survey is being carried out so that this publication can better meet the schools' needs.

ii. Course material. For some topics special booklets have been prepared covering information that may be needed by teachers and pupils. Is this material suitable in form and content? How and when is it being used? And does each booklet give enough or too much information?

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iii. Guidance booklets. Sometimes a specific topic (e.g. engine test beds) may have been worked out in some detail by a member of the project technology team and where this happens a booklet is produced giving all the information necessary for making and using a particular piece of equipment. The evaluators will be able to find out whether such booklets are useful and whether the equipment so produced has opened up new avenues for other fruitful work.

The evaluators' methods will naturally be varied. The readership survey will be carried out by postal questionnaires, whereas the course material will usually entail visiting a group of schools where it is being used experimentally and talking to teachers and pupils about its use. All opinions expressed are, of course, regarded as confidential and directed towards producing the best possible material for the schools.

Project technology has grant-support for a limited period and the final phase of its work is due to be completed in 1972. But already discussions are being held to consider how best to ensure the continuation of the work initiated by the project. Local and regional arrangements will probably be made for helping interested schools and there is talk of setting up a national service to maintain the flow of information, advice and other help which, in a rapidly changing world, is such a necessary help to the teacher.

It may also be of interest to mention the assessment procedure followed in the Science Fair and BBC television competitions. Schools submitting work for exhibition at a local Science Fair are invited to compete in the television series. A team of pupils are then asked to demonstrate their apparatus to a panel of judges and to answer questions in order to establish their knowledge of the scientific background, their general competence and their ability to pursue their own line of development or enquiry. The panel normally consists of two or three scientists and an engineer from a university department. Usually the judges are professors or senior members of staff. A mark is awarded by each judge for each school and the winners from regional groups compete in the national final competition.

Whether as part of project technology or in connection with Science Fairs, there is no wish to establish uniformity in the work. Indeed, the emphasis is upon variety rather than on standardisation, and upon sources of helpful material of all kinds rather than on formal programmes of study, which are regarded as of subsidiary importance. However, certain themes, such as power or the use of photo-cells, may characterise the work of several schools.

Project technology may be evaluated in terms of the changes that it brings about, rather than the extent of the knowledge, skill or understanding it imparts. The following are its most important attributes:

i. it should enable schools to provide enjoyable, even exciting activities, different in character from classroom desk routine. Technological activities should encourage the pupils' initiative and develop their confidence and powers of expression. Success in this field may well reveal unsuspected talent: some of our more intelligent citizens never discovered or committed their full talents while at school;

ii. scientific knowledge is increasing so rapidly that the science teacher's problem is, more than ever, to decide what to leave out. Science teaching is often concerned with discovery and analysis, and it is more difficult to provide opportunities for synthesis and problem solving. Technological project work may therefore provide a useful balancing activity. To this extent it departs from the real life situation where problems have to be faced as and when they arise and not according to some carefully worked out programme. Technological project work may therefore be a useful balancing activity, since, in making a hovercraft or testing an engine, for example, pupils will meet problems long before they would otherwise do so, and, it is hoped, will find ways of solving them;

iii. as far as the crafts and technical subjects are concerned, technology provides the means of understanding the materials, tools and equipment in use and it offers a rich and varied field for designing and making. Whether pupils are producing a piece of equipment to add to the school's resources, making something to ease the lot of somebody less fortunate than themselves, or simply trying out some original idea of their own, they should approach their work in an experimental frame of mind, methodically and with a determination to complete their chosen task to the highest standards of which they are capable.

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7a SCOTLAND

Scotland, although part of the United Kingdom, has her own educational system in which tranfer from primary to secondary school takes place at the age of 12+, one year later than in England and Wales. In the post-war period, secondary education was organised on a selective basis, the abler pupils in some areas going to senior secondary schools and the remainder to junior secondary. In many parts of the country, however, neighbourhood schools were the norm, and senior secondary and junior secondary courses were housed in the same school. This was particularly common in the smaller Scottish towns. Senior secondary courses were of six years' duration, academic in character, but retaining a broad curriculum which included mathematics and science as major elements and technical subjects as a minor subject for boys. Junior secondary courses were of three years' duration, also of a broad general nature, but giving more emphasis to the practical or workshop subjects.

Over the last few years, Scotland, in common with the rest of the United Kingdom, has seen an increase in the number of comprehensive schools, and a great decrease in the degree of selection at the age of 12+. All comprehensive schools have science departments catering for physics, chemistry and biology, and technical subjects departments having workshop, drawing office and laboratory accommodation. Science is part of the curriculum for all pupils during the first two years of secondary education as are technical subjects for almost all boys. Thereafter, pupils begin to select the subjects which they wish to study but every effort is made to retain a balanced curriculum.

In recent years the range of workshop activities seen in schools has been extended so that, alongside the more traditional woodwork and metalwork, one can now find work with plastics and glass fibre, wood sculpture and enamelling, activities based on the study of the motor-car, building crafts and practical electronics. In a number of schools links with subjects such as science, mathematics and art are being strengthened. "Project technology" has had an effect and technological projects covering design, construction, testing and evaluation of "hardware" can be found.

These are usually the results of the enthusiasm of individual teachers but some development on a regional basis is also evident. A number of subject organisers employed by local education authorities are convinced of the value of technology as an element in the curriculum and are actively encouraging schools to participate in project work. Recent exhibitions of schools' activities in many parts of Scotland have reflected their interest.

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A growing number of the abler pupils are being presented for the Scottish Certificate of Education Examination Board's examination in engineering science on the higher grade. The Board's Certificate of sixth year studies papers in science have, as one element, a practical project or investigation, many of which have shown the interest of pupils in the application of science. These trends in the examinations are important in view of the influence which the examination system exerts on education in Scotland.

The training of teachers of technical subjects has recently been under review and new arrangements are about to come into operation. A four year course leading to a diploma in technical subjects is being introduced into colleges of education, and this will form the normal means of entry to the profession. Entrants from industry, however, may be admitted in certain circumstances to a three year course or if their initial qualifications are much above minimum requirements, to a two year course.

7b NORTHERN IRELAND

In educational provision and organisation Northern Ireland is closely akin to England and Wales though there are some differences in nomenclature and at the secondary stage there has been less change from a selective to a non-selective system.

The junior technical schools which flourished during the first half of the century provided a general education in which technical subjects, including practical work, were a major and essential element. The new secondary schools, based on the Northern Ireland Education Act of 1947, have successfully built on this foundation, have enlarged the scope of traditional woodwork, metalwork and laboratory practice to cover a wider range of materials and a greater variety of skills and have developed technology as an activity which helps to link many of the separate components of their curricula. In the older type of secondary school, the grammar school, there is a less generous provision of workshops and in these schools technology tends to be an activity based on science and mathematical subjects.

"Project technology" received an early and warm welcome and further developments are now taking place under its aegis. Science fairs are regularly organised and well supported.

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8. Bibliography

i. General

Ministry of Education. Central Advisory Council for Education (England) "15 to 18" HMSO London 1959.

This is one of the several major documents concerning educational reform. The chapter on "The alternative road" (Chapter 35) is particularly relevant to technology.

Hutchings D.W. and Heyworth P. "Technology and the sixth form boy" Oxford University Department of Education 1963.

In this study the authors sought the reasons why pupils were neglecting opportunites of studying technology.

Semper E. "Technology and the sixth form boy - the teaching aspect" Shell London 1964.

This paper was prepared as a working document by the headmaster of Danum School for Boys, Doncaster, for a course for leaders run by the Shell organisation in London to promote project work in schools.

Page G.T. "Engineering among the Schools", Institution of Mechanical Engineers, London 1965.

This is the report of a survey carried out for the Institution into the state of applied science and engineering in the schools.

Schools Council Curriculum Bulletin 2: "A school approach to technology" HMSO London 1967.

This document was written as the result of a year's study and investigation at the University of Manchester. It traces the historical development of craft and technical subjects in the British system, examines the contemporary economic and social scene and suggests a number of ways in which schools could meet the challenge.

Schools Council Working Paper 18: "Technology and the schools" HMSO London 1968.

This paper was the result of a pilot study to find out how help can be offered to schools wishing to reflect in their curriculum the increasing importance of technology in our society.

ii. PROJECT TECHNOLOGY PUBLICATIONS

(For further details apply to Project Technology, College of Education, Loughborough)

Journals

BULLETIN

The journal of Project Technology. Appears five times a year.
Approximately 48 pages A4.
SATIS (Science and Technology Information Sources for Teachers)
Five issues per year plus annual index. A4.
Subscription details available from Project Technology.

COMPUTER EDUCATION

A joint publication with the Computer education group.
Three issues a year: this may be increased to six. A4.
Price 50 np per year.

Books

SCHOOL SCIENCE AND TECHNOLOGY 1

Descriptions and the case histories of applied science projects and investigations based on the "applications of science".
Exhibition held at Imperial College in September 1968.
220 pages, A5, fully illustrated, price 50 np.

SCHOOL SCIENCE AND TECHNOLOGY 2

Detailed and lucid descriptions of many of the best projects and investigations which were selected for the BBC television series "Science Fair". Written by the producer of the TV series, Mr. Alec Nesbitt.
Produced in co-operation with Esso Petroleum.
Approximately 200 pages, fully illustrated, price 60 np.

PROJECT TECHNOLOGY 1968

Reprints of selected Bulletin articles during 1968.
Approximately 100 pages.

PROJECT TECHNOLOGY 1969

Reprints of selected Bulletin articles during 1969.
Approximately 160 pages.

TEACHING MATERIAL

The following items are selected from the wide range of teaching material being developed by project technology:

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GAS-FIRED MUFFLE FURNACES

Deals with the construction and use of low cost muffle furnaces. Complete details and plans for school construction. 28 pages, A4.

SIMPLE MATERIALS TESTING EQUIPMENT

A companion to the above, this booklet deals with testing techniques using vice-type and universal testing rigs.

PRACTICAL APPLICATIONS OF BERNOULLI'S THEOREM

Describes an inexpensive, easily-constructed, piece of apparatus, based on a standard carboretter which provides pupils with an opportunity for quantitative study of Bernoulli's theorem. 22 pages, A4.

ENGINE TEST BEDS

Describes the design and construction of an engine test bed for schools, using readily-available and cheap commercial components. 20 pages, A4.

PROJECT WORK IN "A" LEVEL PHYSICS

A report on the effects of project work introduced into "A" level physics at Dauntsey's School. By L.S. Taylor. Illustrated, A4.

LOCAL SCIENCE AND TECHNOLOGY CENTRES

Provides authoritative and practical guidance to all those interested in the establishment of local centres for science and technology in schools. Based on the 1970 Warwick Conference "Interface - education and industry".

TECHNOLOGY AND MAN

A series of three packages containing source and stimulus material for use by pupils of middle school age, preferably with an integrated studies situation.

Individual collections;

Title 1	Communications
Title 2	Preservation
Title 3	Energy

Each collection is contained, complete with audio tape and colour slides, in a large plastic ring binder.

iii. Films

CREATIVITY AT SCHOOL

An account of the work of the technical activities' centre at Sevenoaks School (See 5 (ix)).
Shell film library.

EXPERIMENT IN TEACHING

This is a similar film to the above, but dealing with the work of a number of schools noted for their technological work.
Central Office of Information, London.

AN INTELLIGENT CONCERN

A film reflecting HRH Prince Philip's interest in young people and in technological activities in schools. The film shows the Prince discussing project work with some thirty boys and girls. A rich variety of work is shown and there is much frank discussion on the effect of the work upon the individuals undertaking it.
Central Office of Information, London.

Other films and film loops are being prepared by project technology.

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APPENDIX

HAYLE COUNTY SECONDARY SCHOOL, CORNWALL

Hayle is a small industrial town in West Cornwall. In the second half of the eighteenth century a small copper smelter was established in the town, to be followed in 1779 by the iron foundry of John Harvey. There was considerable ill-will, but iron pump pipes and beam engines from Harvey's of Hayle supplied the needs of a flourishing Cornish tin mining industry and, despite all opposition, their pumping engines became famous not only at home but in the lead mines of the North of England and the Welsh collieries, in Peru, Mexico, North America, Australia, Spain and in Holland. Today Cornish mining is virtually finished. The area lives largely by its tourist industry: all that visitors can see of its past are the scarred, crumbling remains of many old engine houses scattered over the moors, and the skeleton of the old foundry at Hayle. The Cornwall Archaeological Society has a very strong interest in plotting and preserving records of the area's industrial past, and the head of technical studies at Hayle County Secondary School has personally played a leading part in its activities.

Industrial archaeology was first introduced to the school early in 1966 as a club activity. By midsummer, interest had grown considerably and it became possible in the autumn to allocate a small sum of money, and a regular afternoon each week on the time-table, to enable a planned survey to be undertaken. At first, pupils concentrated on visiting, photographing and recording data relating to the old foundry, docks, quays and mines, but it soon became evident that what they were really exploring was the history of Hayle's past. Plans were therefore made to develop the project into a full-scale environmental study involving eleven teachers and, in some degree, all of the school's 300 pupils.

The focal point of Hayle's industrial past is an old swing bridge, carrying road and rail traffic across to the quays and docks. Detailed working models were made following many visits to measure, draw, record and photograph the bridge. In the school's science department bridge design, hydraulics and gearing were featured; in mathematics pupils studied design, stresses and loading; geographers drew maps, visited mines and made a survey of copper and its uses; the English department became responsible for recording many interviews with local people; in drama lessons a play was written and produced, depicting life in Cornwall in the 1800s; the needlework department produced costumes for the play, as well

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as making a large mural in appliqué work showing Hayle, its characters and its products; the history department was responsible for collecting and studying documents, clothing and household utensils; in home economics classes girls made once more some of the dishes which formed the staple diet of miners and their families a century ago.

The success of the project was such that pupils visited and talked with interested adult groups, demonstrated their project to pupils of all local primary schools and set up exhibitions in various parts of the county for the benefit of teachers elsewhere. It was completed as a separate study in 1967, but the methods adopted have continued to the present time with constant liaison in particular between the departments of technical studies, geography and science. The school has its own museum, and maintains contact with university departments, local societies and especially with the older local people who in the early days furnished pupils with remembered stories which helped so much to capture their imagination and promote fresh interest.

DANUM GRAMMAR SCHOOL FOR BOYS, DONCASTER

Control technology was first introduced at this school in September 1967 with an experimental group of fifteen 13 year old pupils. The interest aroused was such as to create a demand which the school could not meet with the existing equipment and staffing. Special facilities were therefore provided by re-equipping an existing room as a laboratory workshop, and a member of the science staff co-operated with the head of the metalwork department to develop the work in some detail. At the present time some 80 boys are involved. The aims of the teaching are similar to those stated in Section 2 and, in particular, to provide a sufficient background knowledge of control technology to enable pupils to solve relatively complex problems, including the making, control and automation of mechanical devices.

A basic course of 1½ years' duration involves working through a series of carefully planned programmed investigations and experiments in which the pupils discover relevant facts and principles for themselves. Specially designed, easy to use and reliable equipment is provided. This helps to ensure rapid progress and where necessary important concepts are developed further by teacher demonstration and class discussion. Examples of themes included in the basic course are: structures, rotary motion, linear motion, basic electricity, pneumatic switching, electronic switching, programming, logical circuitry and its application.

On completion of each theme, boys are involved in a "mini" project requiring 1½ hours to 10 hours for completion, during which time the facts and principles learned are applied to a particular problem. Examples of mini-projects include the design, construction and testing of a model bridge, a model lifting device for vehicle loading, a burglar alarm, a liquid level-sensing device, a high load warning system, a turntable position control and a random event counter.

One example of the random event counter project is the design and construction of a device to count people entering a room but not leaving it. A group of three 13 year old boys chose this project having just completed a sequence of basic course programmes concerned with control circuitry. The equipment used was specially designed for speedy assembly and dismantling in order that a number of different solutions could be tried quickly. The final design (see diagram, page 32) consisted of a photo-electric cell A and light source placed across a doorway with a second cell B and light source about 0.75 metres inside the room. Cell A de-energises a relay when its light beam is broken, the relay contacts being used to produce a count on an electromagnetic counter. To prevent

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counting in the reverse direction, i.e. of a person leaving the room, the breaking of the beam incident on B de-energises a relay causing a second delayed relay to energise. The energising of the delayed relay causes a light source C to illuminate. This source, placed adjacent to cell A, illuminates A via a plane mirror. Thus when the main light beam to cell A is eventually broken it has no effect on the operation of the cell and there is no count. The delayed relay de-energises after a short period of time and source C extinguishes. For correct operation the boys realised that it is essential that people leaving or entering the room should do so in single file. To satisfy this requirement they suggested a single narrow entry/exit or turnstile.

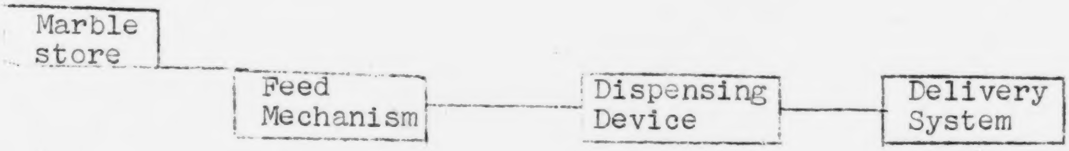
Having completed their investigations and mini-projects, groups of two or three pupils are given engineering problems to solve in a practical situation. These projects are of a relatively simple nature and take about 25 to 30 hours to complete.

Examples of work of this nature are:

a marble dispensing machine;
a nut and bolt counting and packing machine;
a diode testing and sorting machine;
a computer punched card reader to programme a model gantry crane;
an automatic, pneumatically-operated, drilling machine.

The specification of one marble dispensing machine required a known number of marbles to be placed automatically into a box, the number dispensed to be easily varied (any number between 5 and 20) by making simple adjustments to the machine. Three basic ways were tried for controlling the number of marbles dispensed viz. by weighing, by counting, and by stacking (measuring the total length of a column). Five machines were constructed, all totally different. Two machines used the weighing technique, two the counting technique and the other the stacking method.

The machines constructed consisted of the following units:-



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Electrical control circuits were designed and tested using specially designed equipment before individual components were permanently soldered together. The original designs required considerable modification but all the devices eventually satisfied the specification reasonably satisfactorily.

The final year of the course is devoted mainly to a major group project, preferably the solution of a problem encountered by a local industrial concern. One project already undertaken is the design of an automatic exhibition display unit to show the timetables of 12 pupils in a typical comprehensive school.

The present course in control technology at the school is of three years' duration leading to a Certificate of Secondary Education qualification by continuous assessment. Eventually it is envisaged that, with suitable amendments, the work will be examined at Ordinary Level in the examination for the General Certificate of Education. Some neighbouring non-selective schools are adapting the course for pupils of average and below average ability. This is usually for boys only but girls in a mixed school are also involved and it is expected that more girls will wish to take the subject in future. Conferences for teachers have revealed a considerable demand in the schools for work of this kind. The course structure allows for sections, as complete topics in programmed form, to be extracted by schools and used in the teaching of science and craft. Experience in the seven schools associated with the development indicates that most pupils are able to benefit from the experience as part of their general education. The pupils who have taken the course are better prepared for sixth form investigational and project work, particularly in the applied sciences.

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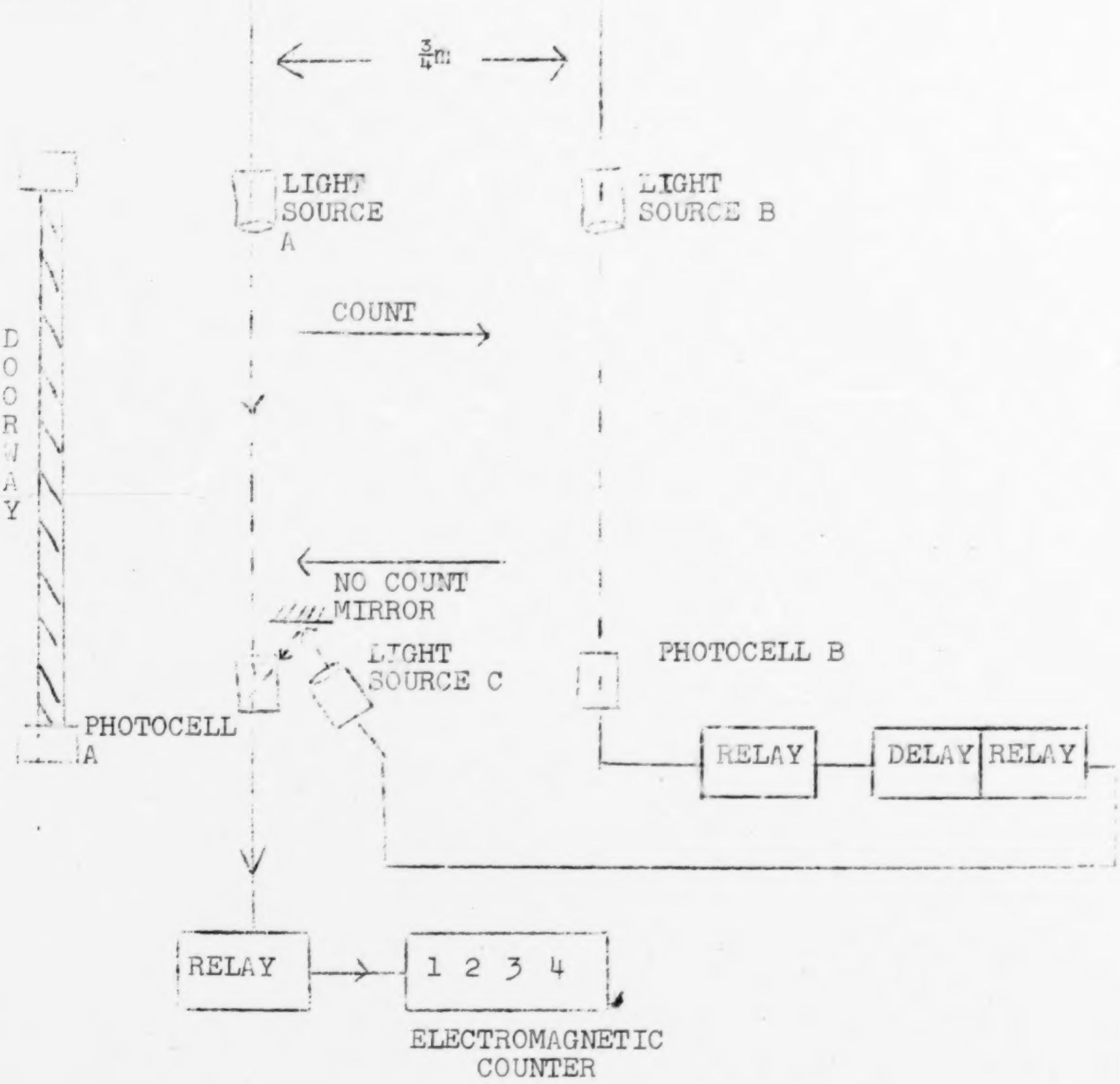

DANUM GRAMMAR SCHOOL FOR BOYS, DONCASTER

BLOCK DIAGRAM OF COUNTING DEVICE

Random event counter (see page 29 para. 4)

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GATEWAY SCHOOL, LEICESTER

Prompted by a suggestion in Schools Council Bulletin No. 2 about various ways in which harmonic patterns could be investigated, a small group of sixth form boys noticed that a secondary pattern was produced when harmohograms were drawn on plastic sheet engraved with lines or dots. This led them to the further discovery that the scale of the Moiré patterns so produced was always greater than the basic unit in the separate patterns. In other words they had discovered for themselves a means of amplifying small dimensions. Two boys one with some knowledge of electronics, decided to build a demonstration electronic comparator, to compare the lengths of manufactured components with a standard gauge. Reference to the literature available soon revealed that the Moiré phenomenon is of course a standard industrial technique used in precision measurement and for the positional control of machine tools. But why were the fringes always inclined at an angle to the grating? Could such a simple phenomenon be applied? After further investigation an electronic vernier indexing device was produced and patented by the school.

Would the present state of the boys' knowledge be adequate for them to design a simple but effective control system for a machine tool? Could electrical pulses generated by fringes be made to drive stepping motors? This further reasoning prompted one team to design a system for the two-dimensional control of an engraving machine. It was a bold proposition and judged by its performance alone it has not yet been entirely vindicated, but a temporary failure can often be used to underline the need to acquire the knowledge and techniques that will lead to ultimate success.

At this stage the boys who had studied the Moiré effect were encouraged by the interest shown by the promoters of the Science Fairs in the United Kingdom to return to the observation they had made very early in their investigations when they had noticed that the gratings superimposed on a harmonogram produced Moiré patterns. Among the technical references consulted at the time was one suggesting that a study of the Moiré pattern produced by plain gratings on fingerprints might provide a basis for developing a system for classifying them. Each of the five members of the team who elected to develop a project on fingerprints contributed to all stages of the enquiry, but each was assigned an area for detailed investigation. The development of an electronically controlled device to scan, identify and distinquish fingerprints is still proceeding after six months or more and the results are said to be encouraging.

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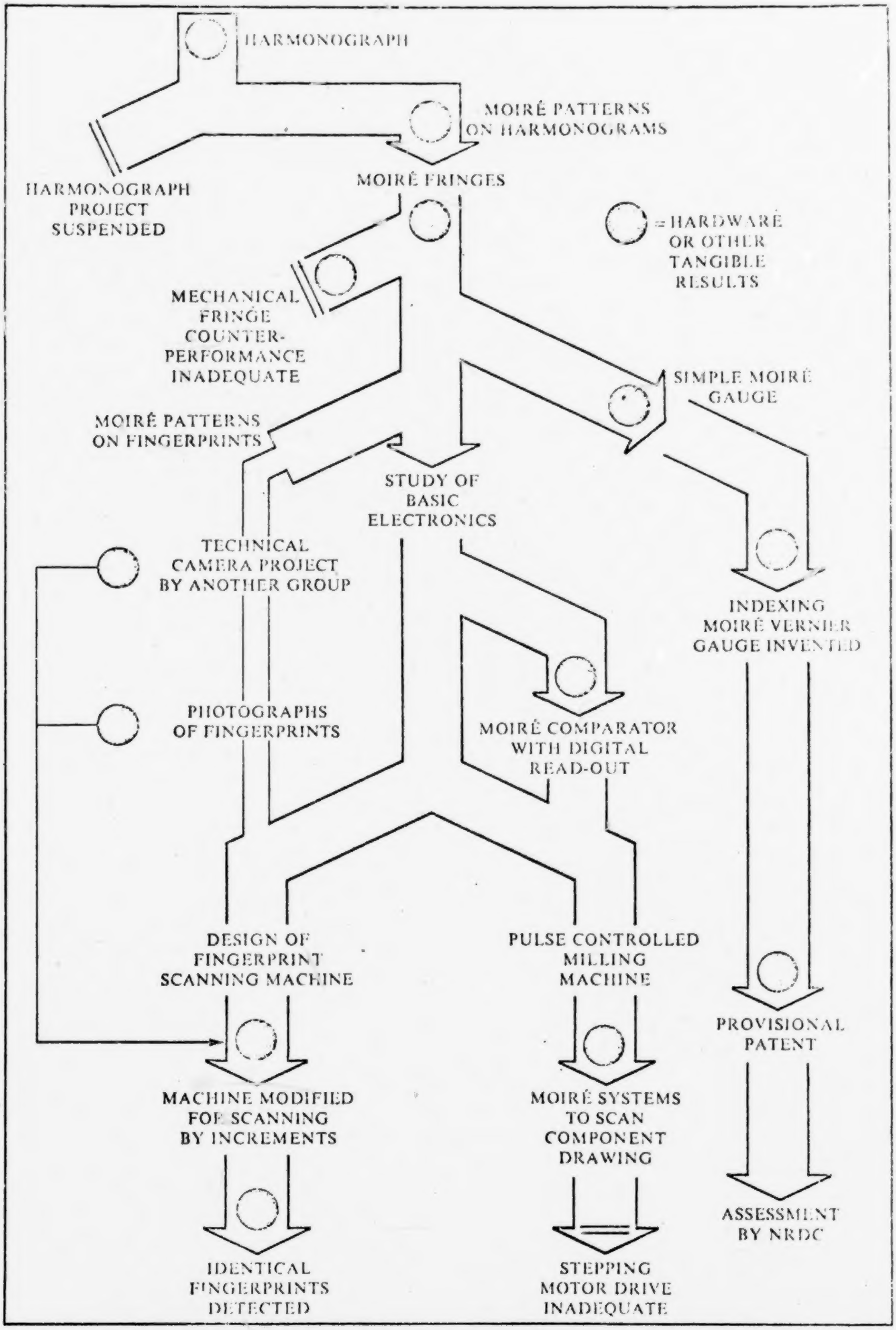
The investigation has won for the group of pupils concerned the award "Young Scientist of the Year" in competition with many other schools throughout the country. It has also won the major award at an international fair for scientists and inventors in Holland. Thus a number of interesting open-ended investigations, beginning with apparently insignificant observations, led to an attempt to devise a new system for the comparison and identification of fingerprints. By using the small armoury of techniques they had acquired on the way, the boys attacked a difficult problem, the solution of which demands the greater resources available to the experts working in the field of pattern recognition. Perhaps the most rewarding aspect of the development is the encouragement and recognition the boys enjoy by having their work seriously examined by experts using criteria that apply to industry and commerce. Their approach demonstrates that by exploring small successes, by remaining alert and by questioning or even challenging the existing state of affairs, their efforts may produce something significant.

Appendix

GATEWAY SCHOOL, LEICESTER


HARMONOGRAPH
MOIRÉ PATTERNS ON HARMONOGRAMS
HARMONOGRAPH PROJECT SUSPENDED
MOIRÉ FRINGES
= HARDWARE OR OTHER TANGIBLE RESULTS
MECHANICAL FRINGE COUNTER-PERFORMANCE INADEQUATE
SIMPLE MOIRÉ GAUGE
MOIRÉ PATTERNS ON FINGERPRINTS
STUDY OF BASIC ELECTRONICS
TECHNICAL CAMERA PROJECT BY ANOTHER GROUP
INDEXING MOIRÉ VERNIER GAUGE INVENTED
PHOTOGRAPHS OF FINGERPRINTS
MOIRÉ COMPARATOR WITH DIGITAL READ-OUT
DESIGN OF FINGERPRINT SCANNING MACHINE
PULSE CONTROLLED MILLING MACHINE
PROVISIONAL PATENT
MACHINE MODIFIED FOR SCANNING BY INCREMENTS
MOIRÉ SYSTEMS TO SCAN COMPONENT DRAWING
ASSESSMENT BY NRDC
IDENTICAL FINGERPRINTS DETECTED
STEPPING MOTOR DRIVE INADEQUATE

Study of Line Patterns. Diagram to show how several projects may develop from the same source.

WOODBERRY DOWN SCHOOL, LONDON

Technology is introduced alongside normal workshop practice for the technical forms in the fourth and fifth years. Since these pupils take the external examination at the end of the fifth year, the projects selected tend to be those which include skills needed for the external examination, but the range of work is nevertheless wide and otherwise limited only by the pupils' attainment. In general, the approach is to show on film and slides examples of work done by other pupils in previous years. The boys are then encouraged to think in terms of a project and to develop their own ideas. Those who do not wish to undertake project work are allowed to carry on with their normal course in metalwork. In this way technology is introduced gradually and the teacher is able to cope with the wide range of work undertaken. Co-operation with other departments is achieved and the pupils are free to consult teachers of other subjects. They are also encouraged to seek the advice of local industrial concerns and universities. Provision is made in the school timetable and after school for technical activities. Selected themes are sometimes used over a wide ability range and cover topics such as communications, transport, navigation and structures. For example, "transport" is used with less able pupils and models of early forms of transport are made during their normal woodwork and metalwork lessons. Model aircraft, both static and flying, are made by those capable of doing so. This leads to more ambitious projects for the more able pupils: the making of aircraft powered by electricity, and of hovercraft in model form powered by internal combustion engines or by electricity; the use of air tracks for transporting sacks of heavy material; and a study of the linear motor monorail. Between these extremes there is plenty of scope for the making of model steam engines, traction or road rollers and for the remote or radio control of trucks and cars Model railway and slot car racing are hobbies of many children and in their manufactured form can excite interest in a more sophisticated approach to their use. Timing runs over a straight section of track or working out lap times and train schedules add an interest which can lead to the modification of the models in order to improve their performance. Much of this work has overlapped other subjects, such as geography, physics and mathematics. Given suitable timetable facilities and goodwill amongst the staff, some of the aspects covered can be dealt with in such subjects, particularly where the examination syllabus is not materially affected.

In the sixth form, the pupils taking science tend to concentrate upon electrically controlled mechanical devices and are encouraged to pursue their investigations as far as possible. Examples of completed projects include light seeking devices, simple computers, radio control and other radio equipment. Sixth form arts pupils (that is, those not taking science as a main subject) tend to undertake work of a social nature, although an end-product in model form is usually produced. In some cases the end-product takes a different form. For example, investigation of traffic black spots in the area necessitated discussions with council officials, photography and analysis, leading to a full report and a suggested scheme for improvement. Another project arose from the disastrous collapse of a section of a block of flats in London.

This approach in the workshop has most of the advantages of traditional methods but it has also added a great deal of interest to the teaching of technical subjects for staff and children. A stable situation has now been reached where the pupils who elect to do project work, mainly on the engineering side, also achieve the skills necessary to pass external examinations. In the sixth form the work is followed mainly for interest and to encourage the development of an enquiring mind.

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TONBRIDGE SCHOOL, KENT

Energy output in school games

A group of boys were watching a cricket match and discussing how much energy was expended in playing the normal range of school games. Opinions naturally differed according to whether the speaker was a squash player, an oarsman or a cricketer. After some discussion, it was decided that it would be interesting to put theory to the test and to measure and compare objectively the energy output for all school games. The first move was to discuss the problem with a boy's father who was professor of medicine at a London hospital, and he arranged a meeting with one of his staff. The school doctor had now become interested in the project and joined the group. During these early discussions it transpired that very little research had been done in this field, a point that was confirmed by an information search carried out in the library of the British Medical Association. It was found that energy output could be measured indirectly by collecting and analysing expired gases, but this meant wearing a cumbersome apparatus which prevented games being played normally, if at all. Indirectly, energy output is related to the heart rate. The average heart rate of the subject had first to be assessed and then his response to exercise, standardised against his performance on an ergometer, using a Douglas bag. Thereafter the energy used could be calculated directly from the heart rate. At this stage the Medical Research Council was approached and they not only took a great interest in the project but provided three instruments for measuring heart beats over a period of time. These were calls SAMIs (socially acceptable monitoring instruments), were the size of a cigarette case, and could be worn during any game. They were connected to the chest wall by electrodes that picked up the heart beat. They contained an electrolytic cell and at every beat a standard amount of silver was removed from the negative pole. After use the silver was re-deposited and the amount of current required to do this was measured on a digital recorder from which the number of heart beats could be calculated. The selection of criteria to be used, the design and production of record cards, the selection of boys for test, and the devising of the tests to be administered involved considerable discussion. A bicycle ergometer had to be designed and built for use as a control on the energy potential of each of the 40 boys tested. All these boys were tested over the complete range of games, in circuit training, during normal school, and whilst asleep, as well as on the ergometer. Many pupils were associated with administering the tests, keeping the test result cards and analysing the results, but the boys concerned had taken part in a project that had grown out of a desire to test a hypothesis and had carried out a small piece of original research in a scientific manner.

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Electro-chemical machining of metals

With the advent of the extremely hard metals that require machining to complex shapes for turbine blades, production and machining costs have soared. Consequently industry is investigating methods, other than the conventional ones, for shaping these metals. ECM is a possible answer to the problem. In the test rig that was designed, built and tested, a potential difference of 12 volts is set up between the tool and the workpiece. Thus, when the electrolyte is flowing between these two parts a current is carried between the tool and workpiece, ionising the workpiece and releasing hydrogen. The ions react to form a residue which is flushed away by the fast-flowing electrolyte. A specific shape can be achieved on the workpiece since the current density, and thus the rate of erosion is greatest where the tool and workpiece are nearest, so that eventually the two are mirror images of one another. This particular project was chosen as it admirably suited the requirements of the boy concerned. The method of machining is a recent development in a field which he hopes to enter, the principle and design of the rig were reasonably simple, the amount of time needed was no hindrance because he had already obtained university entrance, and the whole project was reasonably cheap - costing about £10. From the point of view of the school it was an extremely useful one since the project can be carried forward from year to year, with different boys investigating the same problem from different angles. The actual construction of the rig raised various problems which had to be surmounted. There is little point in operating a machine of this type unless all the moving parts are working perfectly and there are no leaks in the system. This presented a problem as the electrolyte was a concentrated salt solution being pumped through the working section at a pressure of approximately two atmospheres. Nearly all the parts of the rig had to be hand-made and there were considerable problems with the gearing of the synchronous motor which provided a slow feed to the workpiece. A suitable pump had to be found that would operate at the appropriate pressure and would not be attacked by the electrolyte. Valuable experience was gained from having to find sources of suitable materials and from learning to use the necessary tools and equipment. There are several possible lines of research with the rig. One can experiment with the effectiveness of different electrolytes, different feed rates, different currents and voltages, different metals, or different shapes of tool. The present line of research is concerned with the shape of the tool and the resultant machining on the workpiece.

IV. CONCLUSION

The advent of technical education is a real innovation in the teaching world. It is also something really necessary for there can no longer be any culture without technology. A person who is unable to decipher a technical drawing, express himself graphically, analyse a technical object, or make an informed judgment on the environment in which he lives, is uncultured. An educational system which will not accept technology is an educational system which turns out cultural cripples. This is now understood by all European countries and it is proved by the articles which we are providing. But numerous difficulties are yet to be overcome. They are shared by all the countries we have considered: intensive research must lead to a precise definition of technical education and an evaluation of its effects. The training of teachers must be enlarged and space and equipment must be provided to include technology as a coherent element of an educational system.

Research undertaken by the Council of Europe through its Committee for General and Technical Education has been aimed at this for the last ten years.

A highlight of this Committee's work was an intergovernmental course on "The place of technical education in secondary education" in 1965. A number of countries, including France who organised the course, stressed the need to introduce technology to all pupils, regardless of whether they were going to follow theoretical or technical studies. This introduction should not only guide pupils towards technology but also have real educational value. The training and further training of technical teachers were therefore also reviewed by the participants.

This course crystallised and brought to light a genuine awareness on the part of all European countries of the prime importance of technical education in the modern world and the need to integrate this type of training in general education.

Since then the Council of Europe has made the promotion of such integration one of its main objectives in this field.

An offer from the French Government made it possible to organise a second course on technical education in lower secondary schools. This course was primarily intended to inform the representatives of member States of the Council for Cultural Co-operation of the results of several years' experience of technical education in France, and some very interesting findings emerged.

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Technical educational curriculum at the level under consideration was defined very precisely and it emerged in particular that diagram and technical drawing work should have a major place in the syllabus in question.

It would seem that these are the two means best suited to reconcile theory and practice. The creativity inherent in any subject which invokes other subjects and the concept of analysis are best expressed and developed through these two techniques.

The technological dream is rooted in the past, but the era of technology began in the twentieth century and it will be technical education's privilege to give a new face to humanism in our universities.